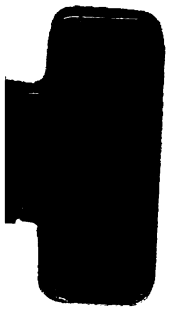

A

PRACTICAL TREATISE

ON THE

USE OF THE OPHTHALMOSCOPE,

BEING THE ESSAY FOR WHICH

THE JACKSONIAN PRIZE,

IN THE YEAR 1859,

WAS AWARDED BY THE ROYAL COLLEGE OF SURGEONS OF ENGLAND.

BY

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London:

JOHN CHURCHILL, 11, NEW BURLINGTON STREET,

1861.

LONDON:
PRINTED BY HARRISON AND SONS,
ST. MARTIN'S LANE, W.C.

TO

WILLIAM HULKE,

THESE PAGES ARE GRATEFULLY AND AFFECTIONATELY DEDICATED

BY

HIS SON.

10, *Old Burlington Street,*
Aug. 4, 1861.

PREFACE.

THE following Work comprises the essay for which the Jacksonian prize for 1859 was awarded by the Royal College of Surgeons of England.

At that time, I had no idea of publishing it, nor would it now appear had I not been repeatedly asked by the students at the Royal London Ophthalmic Hospital for a guide to the Ophthalmoscopic Examination of the Eye. In the absence of any standard work in English on this subject, I determined to publish the essay. Since, however, its utility as it stood would have been limited, the subject given being, "*The Morbid Changes in the Retina as seen in the Eye of the living Person, and after removal from the body, together with the Symptoms associated with the several Morbid Conditions,*" I decided to include *all* the ocular structures, and to give a short account of the optics of the Ophthalmoscope, but, on the other hand, to omit a large number of cases and copious anatomical notes, in order to keep the present work within the narrowest bounds.

Notwithstanding the progress which has recently been made in Ophthalmoscopic diagnosis, very much remains to be

done before anything like a perfect work on the subject can be presented; and in this which I offer merely as an elementary treatise some points are necessarily only just touched.

With regard to the coloured illustrations some apology is due; for though the greatest pains have been taken to obtain accurate representations, the impossibility of procuring an artist possessing the requisite anatomical knowledge and understanding the use of the Ophthalmoscope has given rise to almost insuperable difficulties. The great expense also of these illustrations has compelled me, most reluctantly, to reproduce only a few of the more important original drawings, that this book might not be beyond the reach of students, for whom it is intended.

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PART 1.

OPTICS.

I.

THE CAUSE OF THE BLACKNESS OF THE PUPIL AND THE THEORY OF THE OPHTHALMOSCOPE.

THE blackness of the pupil of the human eye under ordinary circumstances, and the invisibility of the parts behind it, were formerly thought to depend on the complete absorption by the choroid of the rays of light incident upon the fundus of the eye, so that none of them passed out again from the interior of the organ.

The insufficiency of this explanation was shown by Helmholtz,* who remarked that even supposing the choroidal pigment to absorb light more perfectly than any other known substance, yet this alone does not satisfactorily account for the blackness of the pupil, because there are structures situated in front of the choroid which reflect sufficient light to render themselves visible. These structures are the retina, particularly its vascular net, and the optic papilla, a shining, whitish disc, unsubtended by pigment, that reflects most of the rays which fall upon it. The real cause of the invisibility of these parts, is the refraction of the rays by the ocular media. This, as Helmholtz showed, may

* Helmholtz, H., Beschreibung eines Augen-Spiegels zur Untersuchung der Netzhaut im lebenden Auge., Berlin, 1851.

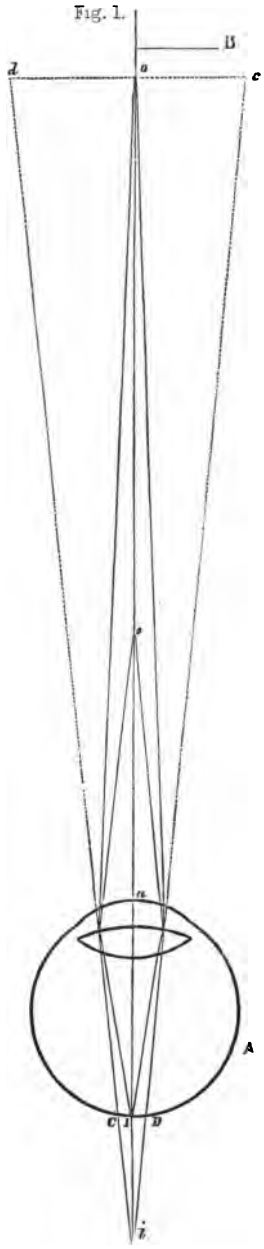
be demonstrated with any small camera obscura, by the simple experiment of substituting an opaque white screen for the piece of ground glass on which the images are formed. He found the eye-piece of a compound microscope also suitable for the experiment, when the length of the tube exactly equals the focal length of the object lens. If, in such an eye-piece, the ocular lens be replaced by a disc of stout white paper, distinct images of objects lying in front of the object lens will be formed on the paper disc, notwithstanding which the interior of the tube when viewed through the object lens, appears absolutely black.

In the eye-piece of the microscope we have an artificial imitation of the eye, its paper disc representing the retina, and its object lens the cornea and lens of the eye. If we remove the object lens from the tube, or if we greatly alter its distance from the paper disc, this at once becomes visible. These phenomena can only be explained by the laws of refraction. When a properly formed eye is exactly accommodated for a luminous object-point, the diverging rays from this incident upon the eye, are refracted by the ocular media in such a manner that they unite at a point in the surface of the retina, which is the image of the object-point. The retina in consequence of its transparency transmits much of this incident light to the choroid, by which most of it is absorbed; but many of the incident rays are reflected, and since these in passing out of the eye undergo a refraction similar, but opposite in direction, to that which, as incident rays, they underwent in entering the eye, their path coincides with that of the incident rays, and they return to the object-point whence they first started. The object-point and its retinal image are thus reciprocal points, they may be considered conjugate foci, each being in turn object or image.

From this it is apparent that without some special contrivance, one person cannot bring his eye into the direction of the rays returning from the fundus of a second person's eye, without at the same time intercepting the incident rays; and since the pupil of the first can receive no rays from the fundus of

the second person's eye, except those which it originally sent to it (and under ordinary circumstances it sends none), the first person sees in the blackness of the second's pupil, merely the reproduction of the blackness of his own pupil.

The eye under examination has been hitherto assumed to furnish a perfect retinal image of the object-point. Where it does not do so, as occurs when the eye is not exactly accommodated for the object, although many of the reflected rays still return towards the object, some are dispersed, and some of these scattered rays will reach the observer's eye whenever it approaches the direct line that connects the luminous object with the eye under examination. Strictly, a slight dispersion occurs even with perfect accommodation, but the smallness of the pupil so lessens the emergent pencils, that, without certain precautions, these do not sensibly affect the observer's retina.



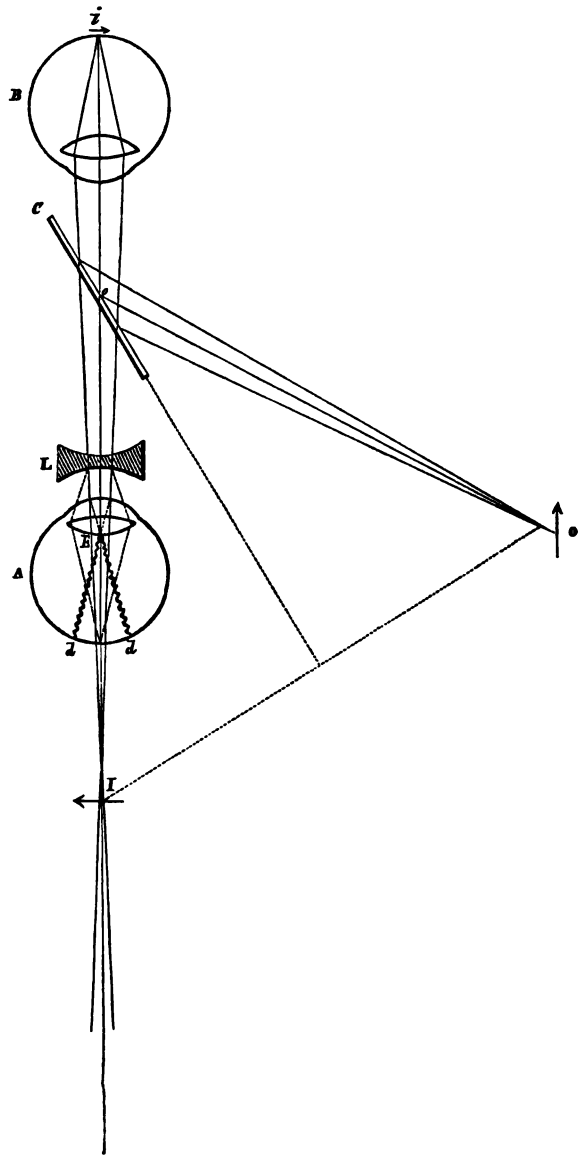
These phenomena of refraction are explained in the accompanying diagram, FIG. 1, in which A is an eye accommodated for the luminous object-point O, at the distance *a* O from A. In this case the diverging rays from O incident on A are refracted by the ocular media, and collected in I, a point in A's retina. This point I is the retinal image of O; and since the rays reflected at I undergo a similar, but opposite, refraction to that which as incident rays they underwent, their outward paths coincide with those of the incident rays, and they can return

only to O. These reflected, returning rays cannot therefore meet the eye of a person at B, to whom A's pupil would appear black. But if whilst A remains accommodated for the distance *a* O, the luminous object-point be brought nearer to A, as at *o*, the image of *o* would fall behind A in *i*, were it not that the incident rays are previously intercepted by A's retina, upon which they form the circle of dispersion C D. Rays reflected from any point in this circle will meet at the distance *a* O, because A is accommodated for this distance, those from C collecting at *c*, and those from D at *d*. In this way a large external circle, or diffuse image of D C, is formed, of which *c d* are limits, and an observer's eye placed at any point between these limits receives some of these reflected rays, and sees A's pupil shine; but for reasons which I shall presently explain does not perceive a distinct image of A's retina.

The most advantageous position for receiving these reflected rays lies in the direct line that connects the source of illumination with the eye under examination; but without some special optical means this has been shown to be an impossible position, in consequence of the necessary interception of the incident rays. By using its mirror-image as an illuminator instead of the luminous object itself, Helmholtz rendered this position possible. His contrivance is shown in FIG. 2, in which A is the observer's, and B the observed eye; O a luminous object, and C a slip of glass, with highly polished, plane, parallel surfaces, inclined at such an angle to the line O *o*, that it reflects the rays incident on it from *o* to B, in the direction they would have if they came from I, where the mirror-image of O appears to B to be situated. This image I, as regards B, takes the place of the luminous object O, and the incident rays apparently proceeding from I form on B's retina a diminished and inverted image of I at the point *i*. Rays reflected from *i* return to C, whence some of them return again to O, but others pass through C towards I, and these reach A. But because a properly formed eye can produce images with diverging or parallel rays only, and these rays are converging,

they intersect at E, and strike A's retina as the circle of dispersion *d d*, producing the sensation of diffuse light, they must therefore be made parallel or divergent before they can be

Fig. 2.



formed into an image of *i* on A's retina, and this Helmholtz effected by interposing a concave lens L between A and C.

If A were placed at some point behind I, then it would receive diverging rays which it could unite in an image of *i*; but then in consequence of the great distance between A and B, A's field of vision would be so much limited by the smallness of B's pupil that the portion of B's retina visible at any one moment to A would be too minute to be mentally joined to the images of neighbouring parts, so as to form a combined picture of the whole fundus.

Finding that the illumination given by a single slip of polished glass was too faint for the satisfactory examination of the minute details of the fundus, Helmholtz increased its intensity by constructing a compound reflector of several slips superimposed in such a manner that the reflections from their several surfaces cover each other, and coalesce in a single image of proportionately intensified brightness. For convenience' sake he fixed this reflector upon one end of a short tube, in the opposite extremity of which he placed the concave lens, and the instrument thus constructed he named the *Eye-mirror or Ophthalmoscope.*

The modifications which this instrument has already undergone since the announcement of Helmholtz's invention, 1851, are so numerous, that I shall only describe those which I myself have found most useful, adopting Zander's arrangement, in three classes,* viz.:

1. Ophthalmoscopes in which the reflector consists of slips of highly-polished glass, with plane parallel surfaces, as Helmholtz's and Follin's.

2. Homo-centric ophthalmoscopes—concave mirrors of silvered glass or metal, as Ruete's and Liebreich's.

3. Hetero-centric ophthalmoscopes—plane or convex specula in combination with a convex lens, as Coccius's and Zehender's. The prismatic ophthalmoscopes, which are but little used, fall under this class.

* Zander, A., Der Augenspiegel, Seine Formen, und Sein Gebrauch. Leipzig und Heidelberg, 1859.

Three principal conditions must be fulfilled in the construction of every ophthalmoscope. 1. It must be able to give a sufficiently bright illumination of the fundus; and 2,—this in such a manner that the examiner's eye can be brought into the line of the rays incident upon the eye under examination, or nearly so, in order that it may receive the reflected rays returning from the latter. 3. It must provide for the proper accommodation of the examiner's eye, so that this can produce a distinct image of the part of the examined eye.

The images seen with the ophthalmoscope are of two kinds: 1. A real, inverted, aërial image situated in front of the eye examined; and 2,—an erect, virtual, geometrical image, which may lie in front of the eye examined, or behind it. The observation of these inverted and erect images of the fundus is termed the examination by the indirect and the direct method. In the indirect method the objects are less magnified, the portion of the fundus seen at once is larger, and a better idea of the relative positions of its parts is gained; this method of examination is also the more easily acquired. The direct method gives greater enlargement, but a smaller portion of the fundus is comprehended in the field; it is, therefore, better fitted for the investigation of minute details than for obtaining a general view. Thus each method has its peculiar advantages, and the selection of one or the other must depend on the work required of it.

II.

HELMHOLTZ'S, LIEBREICH'S, AND ZEHENDER'S OPHTHALMOSCOPES WITH THEIR ACTIONS.

HELMHOLTZ'S OPHTHALMOSCOPE.

In the horizontal sectional view of Helmholtz's instrument, given in the annexed figure (FIG. 3), *a a* is a short blackened metal tube, closed at one end by a plate *b b*, centrally perforated, which supports a hollow, triangular, prismatic metal box *c c c*. The base of this prism is connected with the plate by the short open cylinder *d*, in such a manner as to allow the rotation of the prism on the axis of the tube *a a*. The long side of the prism contains the reflector, composed of three plane polished slips of glass, inclined at an angle of 56° to the axis of the tube, the other end of which contains the concave lens *l*, which is held in position by the friction-tube *f*. The action of this instrument will be understood by reference to the preceding figure (2).

Fig. 3.

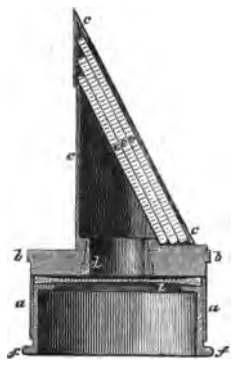
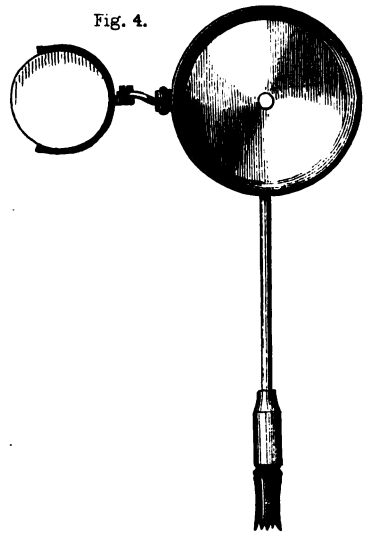


Fig. 4.



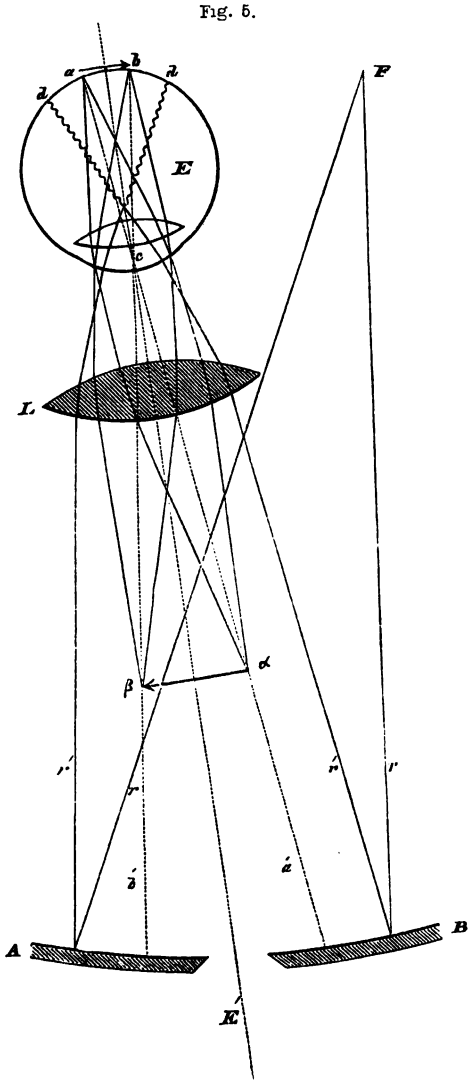
LIEBREICH'S SMALL OPHTHALMOSCOPE.

This ophthalmoscope, represented by FIG. 4, is a concave metal speculum, $1\frac{1}{4}$ inch in diameter, and of about 4 inches focal

length, pierced by a central sight-hole, the diameter of which slightly exceeds one line. The margin of the sight hole is a thin blunt edge. The speculum is set in a metal frame, to which a light handle is attached; and a small clip for an ocular lens is hinged to the frame in such a manner that it can be folded against the back of the speculum over the sight-hole.

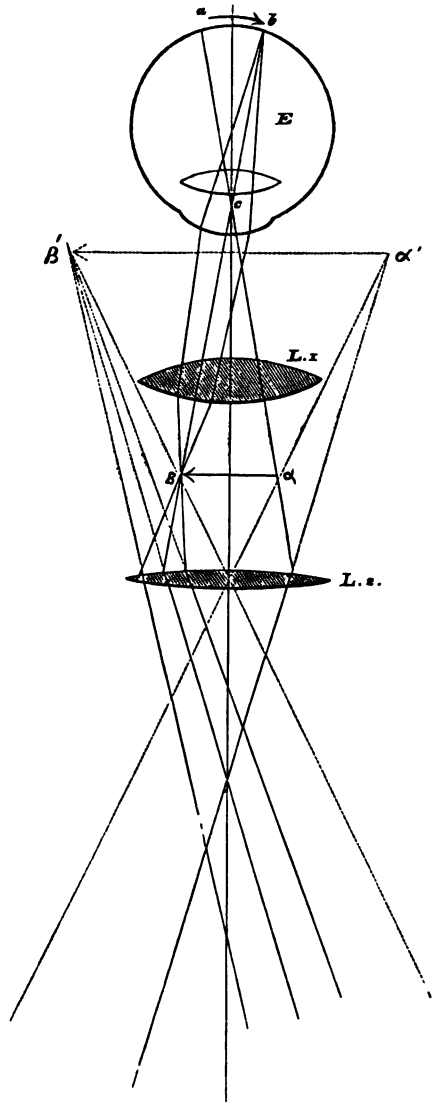
The indirect method of examination (observation of the inverted aërial image) with this ophthalmoscope is illustrated in FIG. 5, where E is the eye under examination, and *c* its optical centre, *r r* are diverging rays from F, a flame, incident upon the speculum A B, which reflects them convergingly as *r' r'* towards E. At a short distance from E the rays are intercepted by L, a biconvex lens of short focal length, which so increases their convergence that they intersect in front of E's retina and illuminate the fundus with the circle of dispersed light *d d*. The pencils from any points *a b* in this circle of dispersion incident on E's lens, returning in the directions *a c*, *b c*, would meet in the lines *a a'*, *b b'*, at a distance from E equal to its anterior focal length, but passing through L, they converge

Fig. 5.



to earlier foci at $a\ \beta$, lying between L and its principal focus, where they form an enlarged and inverted image of $a\ b$ visible to an observer's eye at E′, looking through the sight-hole.*

Fig. 6.



If it be desired to render this image still larger, this is easily effected by placing behind the speculum a second convex lens as an ocular, of greater focal length than the object lens. This arrangement is shown in FIG. 6, in which the rays from $a\ \beta$ after refraction by the second lens, L 2, appear to reach the observer from the much larger geometrical image $a'\ \beta'$.

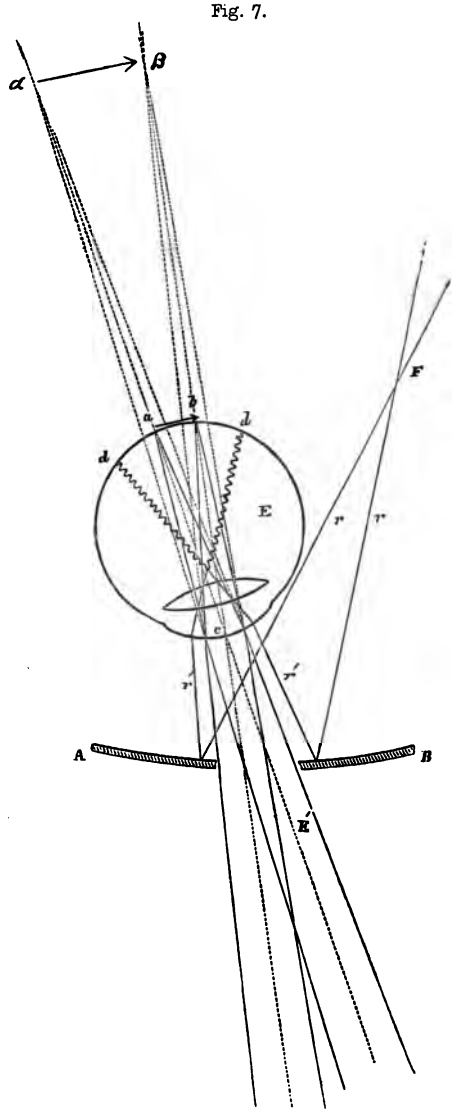
In the direct method of examination (observation of the erect, geometrical image), where both eyes are emmetropic,† and their accommodation is suspended, if the surgeon bring his eye very close to the patient's eye, it will receive parallel, or even slightly diverging rays from the fundus of this, which it

* The pencils traced in this and in the subsequent figures are supposed to pass centrically through the lens L, although really eccentric, in order to avoid complicating the figures. For the same reason several of the constructions are left imperfect.

† A term introduced by Donders to denote eyes which, when accommodated for their furthest point of distinct vision, bring parallel rays to a focus on the retina.

can unite in an inverted image upon its own retina, and this image will be mentally projected as an enlarged, erect, geometrical one, apparently situated behind the patient's eye. But should the patient or the surgeon be myopic, a concave lens will be necessary in order to give the reflected rays the requisite parallelism or divergence, and this lens may be placed either before or behind the speculum.

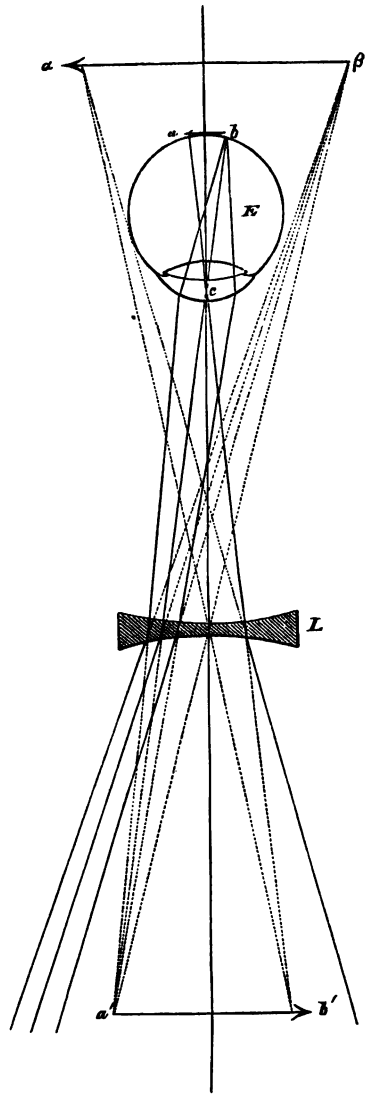
Fig. 7.



The direct method without the dispersing lens is shown in FIG. 7,

E is the examined eye, and E′ the position of the examiner's eye, *r r* are divergent rays from F, a flame, incident on the concave speculum A B, which reflects them convergingly, as *r′ r′* to E, about two inches distant, upon the fundus of which they form the circle of dispersion *d d*. The rays reflected from any points *a b* within the circle, after leaving E, assume a direction parallel to the prolongations of the lines *a c*, *b c* (which pass through *c*, the optical centre of E), and reach the observer's eye at E′, on the retina of which they form an inverted image of *a b*, which is mentally projected as the enlarged, erect, geometrical image *α β*.

Fig. 8.

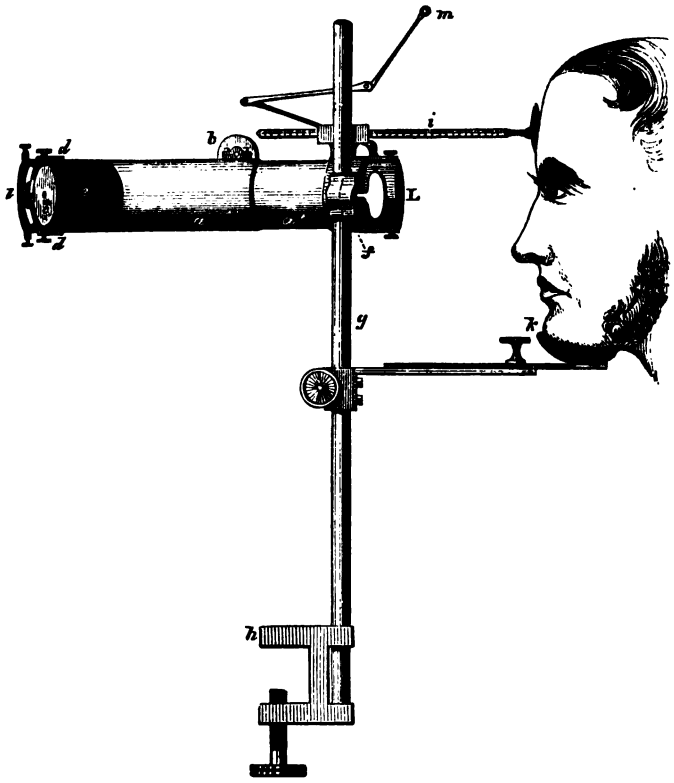


The use of the concave lens is shown in FIG. 8, in which, were it not for the concave lens L, an inverted image of *a b* would be formed at *a′ b′*, at the anterior focal distance of E, but passing through L the rays acquire such a divergence that they appear to come from *α β*, in which plane the observer sees the enlarged upright image of *a b*.

LIEBREICH'S LARGE OPHTHALMOSCOPE.

This instrument, FIG. 9, consists of two tubes, *a* *a'*, one sliding within the other by a rack and pinion, *b*. The tube next the observer, *a*, contains the speculum, *c*, which swings

Fig 9.



vertically on trunnions revolving in the clips, *d* *d*, in such a way that it can be easily removed and replaced. A portion of this tube, at *e*, is cut away in order to admit light to the speculum, behind which there is a narrow slit for a convex ocular lens, *l*, of low power. The tube, *a'*, next the patient contains a convex lens L of about two inches focal length, swung in the same manner as the speculum. This tube is encircled by a stout collar, *f*, which slides on the vertical rod, *g*, so that the whole can be fixed at any

convenient height. The lower end of the rod has a clamp, *h*, for fixing to a steady table. Above, the collar bears a graduated, horizontally sliding rod, *i*, ending in an oval plate, against which the patient steadies his forehead in the manner represented in the figure. Additional steadiness is gained by a chin-rest, *k*. A small brass ball, *m*, mounted on a jointed bracket, forms a convenient object for the patient to fix his eye upon. A couple of small blackened tin shades, not shown in the figure, cut off the direct rays of the lamp from the patient, and surgeon's eyes. The general arrangements in using this instrument are shown in the figure, and its action will be understood by reference to the two preceding diagrams, FIGS. 5 and 6.

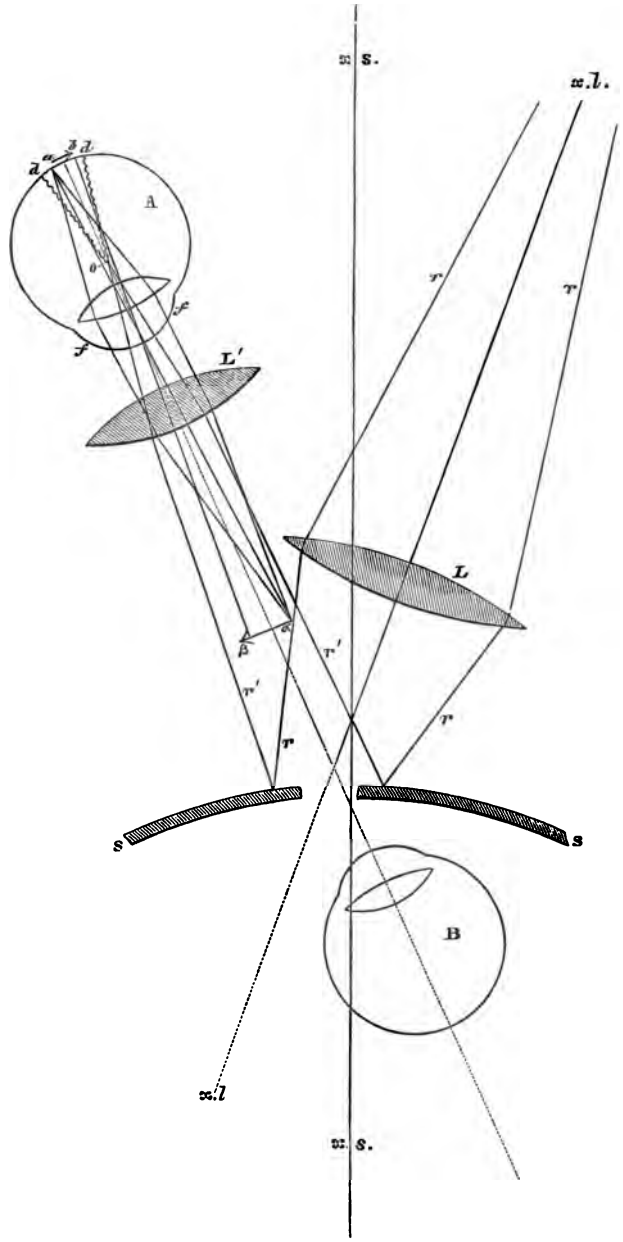
ZEHENDER'S OPHTHALMOSCOPE.

Fig. 10.

Unlike those which have just been described this consists of a convex metal speculum, in combination with a biconvex lens which is of shorter focal length than the negative focal length of the speculum. The clip which holds this lens is mounted on a jointed bracket which turns right and left on the short handle of the speculum. A clip for an ocular lens, is hinged to the side of the frame, just as in Liebreich's small ophthalmoscope.

The annexed diagram, FIG. 11, illustrates the indirect method of examination; *r r* are rays collected by the lens, L, incident

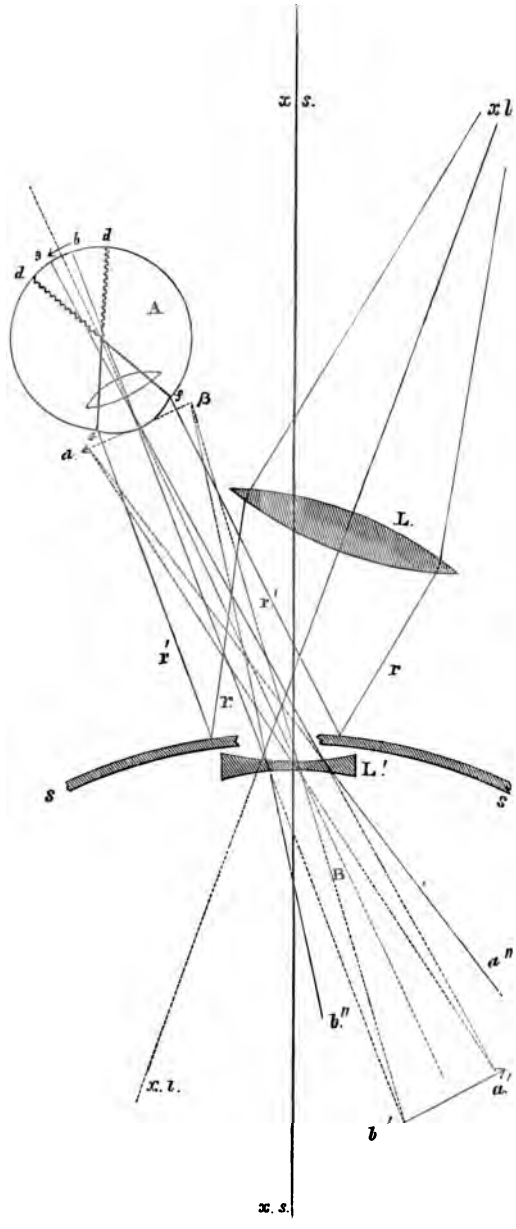
Fig. 11.



convergingly on the speculum, *s s*, which reflects them still

convergent towards A, the patient's eye; before reaching this they are intercepted by the double convex lens L′ which so increases their convergence that they meet at *o*, and then diverging form the circle of dispersion *d d* upon the retina. The pencils incident from *a b*, points in this circle, would meet at some point in the prolongations of *a* ᵅ, *b* *β*, (the lines of direction which cut the optical centre of A), but passing through L′ they are brought to an earlier focus at ᵅ *β*, where they form an inverted image of *a b*. The amplification of this image by an ocular lens, will be understood by reference to FIG. 6.

Fig. 13.



In the direct method FIG. 12, the pencils reflected from *a b* would meet at *a′ b′*, but by passing through the concave ocular lens, L′, they acquire the direction they would have if they reached the observer's eye from ᵅ *β*, where the geometrical image of *a b* seems to lie. The situation of this image is determined

by the focal length of the patient's eye, and that of the dispersing lens. In the case of both patient and surgeon's eyes being emmetropic, the concave lens is not necessary.

ON THE RELATIVE ADVANTAGES OF THESE OPHTHALMOSCOPES.

The illumination afforded by silvered mirrors and metallic specula, is so superior to that given by Helmholtz's compound reflector of unsilvered glass, that in practice they have quite superseded it. The metal specula on account of their smaller size, greater handiness, and less liability to be injured by an accidental fall, are preferable to glass mirrors; but their great superiority over these lies in the smallness of their sight-hole, and the thin edge which this can have given to it in metal. There is a difficulty in piercing so small a hole in glass mirrors, and the larger the hole, the greater the deficiency of reflecting surface, and consequently the larger the central shadow in the illumination. Besides in glass mirrors the sight-hole is not a simple aperture, but really a canal of some length, presenting several edges (those of the two surfaces of the glass, and of its frame), each of which occasions a diffraction which is more or less disturbing to the examiner. On these grounds metal specula are preferable to glass mirrors. For the indirect method of examination I find Liebreich's small ophthalmoscope most convenient and handy, and generally use it; but for the direct method I give the preference to Zehender's, which furnishes a superior illumination at the short distance that, in this method of observation, intervenes between the speculum and the patient's eye; it is, however, less easy to manage.

For demonstrating to a class and for drawing, Liebreich's large ophthalmoscope is very useful. When the instrument and the patient have been once arranged by the teacher, any number of students can in turn observe the appearances.

III.

ON THE MANAGEMENT OF THE OPHTHALMOSCOPE IN THE EXAMINATION OF THE EYE.

When a thorough exploration of the whole fundus is to be made, a full dilatation of the pupil with atropine is absolutely necessary, because a contracted pupil admits but little light, and greatly limits the observer's field of vision. But the disfigurement produced by the excessive size of the pupil is often an annoyance to the upper classes, and the confusion of vision for near objects which the suspension of accommodation produces, is a serious matter to poor persons who work for their daily bread, so that it is desirable to limit the use of atropine, and where a glance at the optic nerve-entrance and the parts immediately around is sufficient for the purposes of diagnosis, artificial mydriasis may frequently be dispensed with. The source of illumination should be a large, clear, steady flame, such as that of a good oil Argand, or moderator lamp, with a chimney, but without a globe. In hospital practice and in the private consulting room, where the ophthalmoscope is in frequent use, nothing is so convenient as gas. The best burners which I have seen are of porcelain; they never corrode, and yield a perfectly noiseless and beautifully steady flame. All gas lamps should have a disc of fine wire gauze fitted beneath the burner to the chimney socket; this subdivides and equalizes the draught, and increases the steadiness of the flame. Chimneys of blue glass neutralize the yellow glare of the flame, and give a pleasant soft light. The flame of a candle is too unsteady and too flickering to be used when any lamp is at hand.

All extraneous light having been excluded by darkening the room, the patient should be seated by a small steady table, on which the lamp should be placed close to the side of his head, in such a position that the flame is in the level of his eye,

and rather behind it, so that his face receives no direct rays from it, and is in the shade.

The surgeon sitting or standing, as may be most convenient, in front of his patient, at about eighteen inches distance for the indirect method, with the ophthalmoscope applied to his own eye looking through the sight-hole, receives the rays from the flame, and by a slight manœuvre reflects them upon the patient's eye, the pupil of which is immediately illuminated with a bright red glow, that changes to silvery white when the eye is turned slightly inwards towards the middle line. Next holding the object lens lightly between the thumb and forefinger of his unoccupied hand, he places it at the distance of about one inch in front of the patient's eye, between this and the speculum, and then by a slight to and fro movement of his own head, he tries to hit off the distance at which the inverted aërial image of the patient's fundus is visible to him; when he has got this, instead of the diffuse silvery glow, he perceives the well-defined disc of the optic-nerve, pierced by the vessels of the retina. The novice is often troubled by the images of the speculum reflected in the object lens; these should be displaced from the centre towards the margin by holding the lens rather obliquely.

In order to bring different parts of the fundus into view, the patient should be told to move his eye in corresponding directions; or the patient keeping his eye fixed steadily upon some object, the surgeon by a slight movement of his own head scans successively the entire fundus. A most convenient object for the patient to fix his eye on, is a large screen behind the surgeon, marked out in squares, each of which is indicated by a figure. Where he is unable to perceive objects, his eye may nevertheless generally be brought into the desired direction by making him look at his hand, held in the corresponding position.

For the examination by the direct method, the pupil should be fully dilated, and the accommodation paralyzed with atropine; the patient and lamp should occupy the same relative positions as they do in the indirect method, but the surgeon must

bring his eye within a much shorter distance of the patient's eye, an inch and a-half to two inches. In approaching so closely to the patient's eye, if a concave speculum, as Liebreich's, is used, much light is cut off by the outer margin of his orbit, and the illumination of the fundus is proportionately dim; but at these short distances Zehender's ophthalmoscope still illuminates brightly, and for this reason its employment is preferable in the direct examination.

The use of dispersing lenses has been explained at page 12.

A methodical plan of examination cannot be too much insisted on; with method, the scrutiny of the whole fundus is very expeditiously and thoroughly performed, whilst its absence brings with it slovenly and imperfect work.

It is most natural to examine the several structures in the order in which they occur from before backwards, commencing with the cornea, the pupil and lens, then passing to the vitreous humour, and finishing with the retina, optic-nerve, and choroid. The media should be examined by the direct method; this should be checked by examination with oblique illumination; then the retina and choroid should be scanned with the indirect method, and the appearances compared with those of the direct method; and lastly, the fundus of one eye should always be compared with the other.

PART 2.

THE APPEARANCES OF THE HEALTHY STRUCTURES.

(Plate I, Fig. 1.)

I.

THE REFRACTING MEDIA.

Where they are perfectly healthy, the examination of the transparent media gives a negative result. They should be explored with the speculum alone, without an object lens. Small threads of mucus or beads of froth on the front of the cornea sometimes mislead persons unaccustomed to use the ophthalmoscope; the illusory appearances they produce vanish when the cornea is swept by a winking movement of the eyelid.

II.

THE OPTIC NERVE AND RETINA.

The optic nerve piercing the sclerotic and choroid a little below and to the inner side of the axis of the eyeball, is brought into view when the cornea is turned slightly towards the middle line, because this is attended by a corresponding outward excursion of the posterior pole of the globe.

The intra-ocular end of the nerve, the optic papilla, optic nerve-entrance, or optic disc, as it has been variously called, is a circular greyish-pink disc, encircled by a double ring, and pierced by the trunks of the retinal vessels, which in consequence of the transparency of the nerve tissue in this situation can be traced backwards towards the lamina cribrosa. The two rings are the apertures in the choroid and sclerotic, the former of which is the smaller, and constricts the nerve more closely. In consequence of this disposition of the parts the extremity of the nerve is first encircled by a belt of choroid, and then beyond this by a narrower white ring, the edge of the sclerotic foramen. The presence of an excess of pigment in the choroid ring, produces the common appearance of a black, or sepia-coloured, incomplete circle, which is no sign of disease, but merely a peculiarity of development.

The colour of the optic disc and the distinctness of its outlines depend on the amount of blood circulating in it, on the mode in which the large vessels traverse it, the degree of illumination by which it is seen, and very much on the colour of the adjacent fundus.

Thus the pinkness of the optic disc is assimilated in a degree proportionate to the fulness of its capillaries, to the redness of the surrounding fundus in eyes in which the choroid contains a minimum amount of pigment, as in those of persons of fair complexion; and the more closely the colour of the optic disc approaches that of the fundus round about it, the less conspicuous are its outlines. Again, where the choroid abounds in pigment, as it generally does in persons of dark complexion, the less highly-coloured optic disc contrasts strongly with the deep orange-red or brownish-red colour of the fundus. In such eyes, especially when brightly illuminated, the centre of the optic disc receives a silvery glow from the light reflected within the nerve from the lamina cribrosa. This reflection is intercepted in cases where many large vessels are crowded together at the centre of the disc, and is most conspicuous where

the centre is traversed by a single arterial and venous trunk, or where the trunks pierce the disc excentrically.

The recognition of the minute structure of the nerve requires a bright illumination, and some proficiency in the direct method of examination. Under favourable circumstances the bundles of nerve fibres appear as delicate radiating lines.

The optic disc rises very slightly above the general curve of the fundus oculi, and does not project into the vitreous humour in the form of a conical papilla, as it was formerly thought to do. Its centre is even slightly depressed where the nerve-fibres are deflected on all sides towards the retina; and its circumference alone is slightly raised, where the aggregate nerve-bundles for the entire retina bend round the margin of the choroidal foramen.

The retinal artery and vein traverse the centre of the optic disc, or as commonly pierce it excentrically, in which case they lie generally nearest its inner side. The number and the arrangement of their branches at the disc depend on the early division of the main trunks within the cylinder of the nerve, or their later division at the surface of the disc. The artery, distinguished from the vein by its smaller calibre, and its lighter red or scarlet colour, very commonly first divides at the surface of the disc into an upper and a lower branch, which subdivide near the periphery of the disc, and are distributed to the retina. The veins which are larger than the arteries, and of a deeper red or crimson colour, usually leave the surface of the optic disc separately, and unite in a single trunk within the nerve. Besides these large branches, the optic disc is traversed by numerous small arterial and venous offsets, some of which spring from the main trunks within the nerve. The living retina, though a sufficiently good reflector, is so transparent that its recognition requires much practice with the ophthalmoscope. It is most easily recognized in eyes in which the choroid abounds in pigment, because this damps the splendour of the sclerotic

reflection, and prevents its overpowering the fainter retinal image. In such eyes the retina appears to overspread the choroid as a thin bluish, or greyish haze, and in the neighbourhood of the optic nerve, with good illumination and sufficient enlargement, the radiating bundles of nerve fibres are discernible.

The retinal vessels give very distinct images, and can be followed from the optic disc forwards to the neighbourhood of the ora serrata. The principal arterial branches divide dichotomously, and their course is straighter than that of the veins, which run tortuously and receive tributary veinlets at large angles. The upper and the lower hemisphere of the retina, each receives from the main trunks at the optic disc two large arterial and two venous branches; those which supply the outer half of the retina diverge as they approach the yellow spot, passing above and below it, so that this part has only capillary vessels distributed to it.

III.

THE VISIBLE PHENOMENA OF THE RETINAL CIRCULATION.

Two pulses, a venous and an arterial, are seen at the optic disc. The venous was discovered by Van Trigt* in 1853, and nearly at the same time, and independently, by Coccius;† and the arterial pulse was first observed by Dr. Ed. Jaeger.‡

The venous pulse is a rhythmical movement of the column of blood in the large veins, and is only exceptionally, and in a modified form, observed beyond the limits of the optic disc.

* Van Trigt, A. C. De Speculo oculi, ejusque usu. Utrecht, 1853.
„ Nederl. Lancet, 3 Ser. 2 Jaarg., bl. 456.

† Coccius, A. Ueber die Anwendung des Augenspiegels, Leipzig, 1853.

‡ Jaeger, Ed. Ueber Staar und Staaroperationen, nebst anderen Beobachtungen und Erfahrungen. Wien, 1854.
„ Wiener medicin. Wochenschrift, Nos. 3, 4, & 5. 1854.

Jaeger, who bestowed great pains on the investigation of this phenomenon, believed the visible blood-movement to be restricted to those portions of the veins which are only partially imbedded in the nerve substance, or which lie freely upon the inner surface of the optic disc, but the accuracy of this view was questioned by v. Græfe,* according to whose observations the pulsatile movement is limited to those portions of the veins which lie entirely inclosed in nerve-tissue. This was supported by Donders,† who demonstrated by vertical sections through the optic disc and adjacent retina, that even those large vessels which appear to project in high relief from the surface, are covered by a thin stratum of nerve fibres. Such sections may be easily cut, if the tissues have been first hardened by immersion in a solution of chromic acid.

From Van Trigt's description we infer that he regarded the venous pulse as systolic, but the observation made by Coccius that the artery and vein are in opposite states of fulness, the arterial systole being synchronous with the venous diastole, is opposed to this view. Coccius also made the very important discovery, that where pulsation is not spontaneously present, it may always be artificially produced by pressure on the eyeball with the finger. He explains the formation of the venous pulse in the following words;—"The retina is placed within a closed elastic capsule. When now by the heart's systole, and consequently at the general diastole of all the arteries entering the globe, a pressure is exerted upon the ocular capsule, the sum of this pressure must show itself chiefly in those places which soonest yield to the pressure; and inasmuch as these (the soonest yielding parts) are the vessels which convey away the blood, the veins, an increased pressure must be exerted upon them during the common diastole of all the arteries which enter

* Von Græfe. Notiz über die Pulsphenomene auf der Netzhaut. Archiv. f. Ophthalmologie, Bd. i, Abth. 1. Berlin, 1854.

† Donders, F. C. Ueber die sichtbaren Erscheinungen der Blutbewegung im Auge. Archiv. f. Ophthalmologie, Bd. i, Abth. 2, S. 75. Berlin, 1855.

the globe, and consequently they must be narrowed, and made to empty their blood more quickly." According to this explanation, the blood contained in the veins at the optic disc is squeezed out of the globe by the increased intra-ocular pressure which attends the common arterial diastole. But this is not favoured by the direction in which the vein collapses, for, as Jaeger pointed out, the vein empties its blood in a retrograde course from the centre towards the circumference of the optic disc, and refills in the opposite direction, centripetally. Distinct from the venous pulse, Jaeger also describes a rising and falling movement of the blood in that part of the vein which lies perpendicularly to the surface of the optic disc. But this movement and the venous pulse are parts of the same phenomenon, due to one and the same cause, the exalted intra-ocular tension which accompanies the collective diastole of all the arteries piercing the eyeball. At the moment of this common arterial swell, every unit of the inner surface of the eyeball sustains an increased pressure; the end of the optic nerve bears its share of this, and since the vein is the most yielding part its contents are squeezed out, some of the blood being ponded backwards, whilst the rest escapes from the globe. The extent and the appearance of the pulsatile movement of the blood in the vein depend on the relation of the vessel to the nerve-tissue. Thus the movement has a minimum range in a vessel which lies vertically to the surface of the optic disc, and resembles in this case a rising and falling cone; whilst a vein which pierces the optic disc obliquely has its empty and distended portions connected by a tapering thread.*

I have never been able to satisfy myself of the spontaneous existence of a venous pulse in the healthy eye, as a natural phenomenon, which Donders asserts.

The pulse in the retinal artery, a rapid to and fro movement, is synchronous with that in the other arteries. The following

* Von Græfe. Loc. cit.

is v. Græfe's explanation of it;—"When the resistance is great, the continuous pressure exerted by the artery upon its contents no longer suffices to force the blood into the interior of the eye, yet during the diastolic increase of blood-pressure a wave of blood is forced through the sclerotic foramen. Now, because the intra-ocular portion of the artery is found completely empty at the moment of this periodic influx of blood, the wave, although a weak one, causes a sudden expansion of its walls, and a rhythmically recurring pulsatile movement, whilst with a natural tension of the arteries a much larger wave would not give rise to a pulse."

A visible pulse in the retinal vessels is a sign of excessive intra-ocular pressure, and the arterial indicates a higher pressure than the venous pulse does. In studying these pulses artificially produced by pressure with the tip of the finger on the healthy eyeball, it will always be found that a moderate pressure suffices to produce the venous pulse, and at the same time it slightly blanches the optic disc; firmer pressure flattens the veins, renders the venous pulse small, whitens the optic disc more, and brings out the arterial pulse. A little more pressure completely empties the veins, and thoroughly blanches the optic disc, the arterial pulse being rendered very conspicuous by the white background. Slight additional pressure causes the arterial pulse to disappear, and now a slight oscillation of the blood in the large veins near the optic disc is occasionally visible. This was attributed by Coccius, who first noticed it, to the increased pressure attending the collective diastole of all the choroidal and ciliary arteries, and led him to infer that the common diastole of these vessels is a joint factor with the diastole of the retinal artery in the production of the venous pulse.

IV.

THE YELLOW SPOT.

This important part of the retina, lying in the axis of the eyeball, comes into view when the eye is fixed upon the ophthalmoscope. It should be examined with a high power. It is best distinguished in eyes in which the choroid contains a medium amount of pigment, both very dark and very light choroids are less favourable for its recognition. Of a circular or oval figure, this spot is distinguished from the surrounding parts by the dulness of its image, and by the greater richness of the choroid in pigment. At the centre of the spot an experienced observer may sometimes detect a small bright dot, which is the fovea centralis; but persons unfamiliar with the ophthalmoscope frequently mistake the retinal image of the speculum for it.

V.

THE HYALOID CANAL AND ARTERY.

With the completion of the development of the lens the hyaloid artery undergoes obliteration, and after this time, in the human eye, usually no trace of this vessel or of the canal in which it ran is discernible with the ophthalmoscope; but in rare cases a vestige remains in the form of a slender thread which runs forwards from the optic disc into the vitreous humour towards the lens. In the only specimen which I have had an opportunity of examining, this thread consisted of wavy parallel fibres of connective tissue. In the eyes of oxen a small white cone projecting from the optic disc into the vitreous humour was found by H. Müller, who says that in calves' eyes it occasionally contained vessels with blood in them.*

* Müller, H. Ueber die Arteria Hyaloidea als Ophthalmoscopisches Object. A. F. O., Bd. ii, Abth, 2, S. 65.

VI.

THE CHOROID.

The red colour of the fundus of the living eye, which first strikes the observer, has been ascribed to the reflection of red light by the vascular nets of the retina and choroid, and particularly by the choriocapillaris; but strictly it is chiefly due to the coloration by the choroid of the light returning through it from the inner surface of the sclerotic. The particular tint mainly depends on the relative proportions of blood and pigment present in the choroid. Thus, a small amount of pigment with a natural fulness of the choroidal vessels gives the fundus a bright, clear, red colour, slightly tinged with orange, the larger choroidal vessels being distinctly visible. A little more choroidal pigment imparts a more decided orange. The pigment is always most abundant in the spaces between the large veins, and where present in very large quantity, the fundus is brownish-red, and the veins appear as lighter streaks between dark interspaces. In this way the veins map out the choroid in small insular spaces, which in swarthy persons are deep-brown, with a violet tinge. This colour uniformly pervades the entire fundus in negroes' eyes, the largest choroidal veins being wholly concealed by the large quantity of pigment. The brightness of the fundus is greater in young than in old persons, and it decreases from the optic-nerve to the ora serrata. This is most noticeable when a moderate illumination is used. The granulated texture which the surface of the choroid has when highly magnified is produced by the minute mosaic of its epithelium.

The details of the chorio-capillaris which some observers have described as visible in the living eye, I have hitherto failed to recognize; and this is not surprising considering that the average diameter of the capillaries is much less than that of the epithelial cells which are only visible as small dots. The presence

of pigment in front of and around these vessels is an additional reason why they escape detection.

The arteries and veins of the choroid cannot be distinguished by their colour as those of the retina may, but their venous or arterial nature is signified by their size and arrangement. In young and fair persons the posterior ciliary arteries may be traced from near the optic-nerve, where they pierce the sclerotic, forwards towards the equator; and the details of the vasa vorticosa with their tributary veinlets form a most beautiful picture.

VII.

THE SCLEROTIC.

The inner surface of the sclerotic reflects more light than the choroid and retina together do; but in the human eye it is only under highly favourable circumstances, such as obtain in albinos, that we get proof of light penetrating the substance of this coat. In these pigmentless eyes it is sometimes possible to follow the ciliary arteries in their oblique passage through the sclerotic.

PART 3.

THE OPHTHALMOSCOPIC APPEARANCES OF DISEASED STRUCTURES AND CONGENITAL IMPERFECTIONS.

I.

MORBID APPEARANCES IN THE TRANSPARENT MEDIA.

OPACITIES in the ocular media, even when exceedingly minute, are readily discernible with the ophthalmoscope; but the learner often has some trouble in fixing their locality and nature, owing to the difficulty he has of estimating the depth at which the opaque objects lie, and to their not appearing in their true colours when seen in transmitted light, but rather as dark shadows on a bright ground.

The information obtained with the ophthalmoscope should be controlled by an examination of the same parts by reflected light, which shows the objects in their real colours; and this may be done either by obliquely throwing a pencil of light into the eye with the ophthalmoscope and looking slantingly past the margin of the mirror, instead of through the sight-hole, or by concentrating the rays from a lamp with a collecting lens on the object which is then viewed through a second magnifier.

The Cornea.—Opacities in the cornea distinguish themselves from those in the vitreous humour by exactly following the movements of the eyeball, and by their relation to the iris, which

show them to be fixed and superficial; the small beads of mucus and bubbles of froth, which so often mislead the learner by their vertical movement, vanish on wiping the cornea quickly with the upper eyelid. By oblique illumination the faintest nebulæ are rendered conspicuous, and the smallest inequalities of surface show themselves by flaws in the reflection.

Conicity, even when present in very slight degree, is easily detected with the ophthalmoscope. The apex of the cone forms a brilliant circular spot, surrounded by a deep shadow which corresponds to the base. In this shadow distorted and indistinct images of the retinal vessels are visible, having an apparently circular motion round the cone, communicated to them by the movements of the globe.

The Lens.—Opacities of the lens resolve themselves into two classes—those on the capsule and those of the lenticular substance.

Opacities upon the anterior capsule of the lens (which itself never loses its transparency) consist for the most part of lymph and pigment derived from the iris. The pupil when dilated is indented, and its margin is tied by fibrous cords, which often branch as they spread out on the lenticular capsule; such cords have a pearly, silky texture, or are coloured with uveal pigment; they do not reach quite to the centre of the lens, but start from points in a circle which corresponds to the position of the pupil at the time the lymph was poured out. (Plate IV, Fig. 3.)

I have a few times met with a similar cordage tying the iris to the lens, but having this difference, that the threads were coloured like the iris, and started from its lesser circle instead of from the edge of the pupil; these were traces of the pupillary membrane.

Masses of uveal pigment on the capsule are black and very sharply defined objects; they are sometimes left as a broken ring when the pupil has dilated and snapped its adhesions to the lens.

Striated opacities of the lenticular substance are dark lines converging from the circumference towards, or radiating from, the poles, which cannot be mistaken; the direction of their curves indicates their situation in the front or back of the lens. Between the striæ the lens is transparent or hazy; or there is a general haziness with few or no striæ.

All these forms of opacity upon or in the lens are fixed.

The vitreous humour.—Inflammatory products, broken dissepiments of hyaloid membrane, and blood clots, constitute most of the opacities of the vitreous humour. Those of the first kind impart a uniform cloudiness, damping the brightness of the fundus, or they produce woolly opacities (of fibroid tissue), often in the neighbourhood of the ciliary processes. Opaque hyaloid membrane forms very delicate gauze-like webs. These objects are defined, and they are usually tossed about by the communicated movements of the eyeball.

Blood-clots are dark, ill-defined masses; the vitreous humour for some distance around them is cloudy; and they prevent the recognition of the parts behind. Their true colours only appear at their edge or when they are obliquely illuminated.

II.

CONGENITAL DEFECTS.

1. COLOBOMA OF THE OPTIC NERVE, RETINA, AND CHOROID.

In many cases of congenital cleft, *coloboma*, of the iris, it is now well known that a similar defect occurs in the sheath of the optic nerve, and coats of the eyeball, owing to an imperfect closure of the fissure which grooves the lower hemisphere of the embryonic eye from back to front. This fault shows itself as a

white oval or pear-shaped figure, stretching along the lowest part of the fundus, the larger end including in extreme examples the optic disc, and the smaller end narrowing anteriorly towards the ciliary region, and terminating near the cleft in the iris.

When the coloboma is of less extent and does not include the optic nerve, the larger rounded end of the white oval figure is separated from the optic disc by a strip of normal choroid; but where the sheath of the optic nerve is imperfectly closed, the upper half of the optic disc has its natural sclero-choroidal boundary, and the lower half where the sheath is deficient is apparently continuous with the white oval, from which it is distinguished by its greyer colour and duller reflection. The floor of the coloboma formed by the inner surface of the sclerotic projects outwards, its border is sharply defined by the choroid. The retina in some cases appears to bridge over the posterior extremity of the hollow, in others it closely follows the outward curve of the surface. The vessels which supply the lower half of the retina are usually fewer and smaller than those which are distributed to the upper half.

2. ABNORMAL POSITION OF THE OPTIC DISC.

No instance of this rare congenital error has come under my own observation. Desmarres, who appears to have seen several cases, says that the faulty position usually lies outwards from the normal one, and remarks that vision is generally greatly impaired owing to disuse of the organ.* In a case published by Professor A. v. Græfe, when both eyes were fixed upon a distant object lying in the middle line, so that the lowest point of the left cornea was opposite the centre of the lower eyelid, the same point in the right cornea, lay two lines to the inner side of the middle of its eyelid, the optic axis of this eye shooting inwards past the object to a corresponding extent; and when the left eye

* Desmarres. Maladies des Yeux. T. iii, P. 507. Paris, 1858.

was closed, the axis of the right eye did not move outwards to the object, as it would have done in a case of common converging squint, but remained in the same position, the object being sharply distinguished.

In the ophthalmoscopic examination it was found that when the patient's left eye was fixed on an object lying 15° to the inner side of the middle line, the optic disc was in the centre of the observer's field of vision, and had passed out of it when the convergence reached 30°. The same happened with the right eye, but in consequence of the aberration of this eyeball, when the patient was told to fix the eye on an object 16° to the inner side of the middle line, the cornea stood as much inwards as the left did when the patient looked 30° inwards. The relative positions of the optic axis and the axis of the optic nerve were not changed; the macula lutea was normally distant from the optic nerve entrance, but it was eccentric with respect to the posterior pole of the globe, owing to the aberration of the nerve.*

III.

DISEASES OF THE OPTIC NERVE-ENTRANCE, OPTIC DISC, AND RETINA.

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1. ALTERATIONS OF THE OUTLINE OF THE OPTIC DISC.

Slight variations in the figure of the optic disc so frequently coexist with perfect vision, that a limited departure from a perfectly circular form must not be hastily looked upon as evidence of disease; it is frequently merely a congenital pecu-

* V. Græfe. Fall von Scheinbarer Netzhaut-Inkongruenz durch anomalen Eintritt des Nervus Opticus. Archiv. F. Ophth. Bd. i, Abth. 1, S. 435. Berlin, 1854.

liarity produced in some cases, perhaps by a more oblique perforation of the ocular tunics by the cylinder of the nerve.

An elliptical figure with the major axis vertical, is a very common deviation of this kind; but an ellipse with its longer axis horizontal is, I think, never met with except in disease. A ragged border and an indented angular disc are common effects of inflammation.

2. SURFACE-ALTERATIONS OF THE OPTIC DISC.

The alterations which the surface of the nerve undergoes are of two kinds, depression and elevation, of which the former is by far the more common. Here it is necessary to warn against mistaking the slight hollow, which naturally exists where the retinal vessels pierce the disc, for a sign of disease. Its extent and depth vary within certain limits, which are determined, as H. Müller first showed, by the manner in which the outer strata of the retinal elements behave at the sclero-choroidal foramen.* Where these slope off gently towards the foramen, the hollow is broad and relatively shallow; but where, on the other hand, they end suddenly, and present an almost vertical face at the foramen, the hollow is narrow and relatively deep.

The depression of the optic disc, which is the consequence of disease is general or partial, and occurs in two forms:— 1. Where its surface slopes gradually and evenly from the periphery to the centre; and 2. Where the hollow commences abruptly at the periphery.

The signs of depression of the surface of the optic disc are a peculiar behaviour of its vessels, and certain effects of light and shade. (Plate IV, Fig. 2).

Where the hollow is slight, and the slope gradual, the smaller vessels afford safer evidence than the large, because, on

* Müller, H. Ueber Niveau-Veränderungen an der Eintrittsstelle des Sehnerven. Archiv. F. Ophth. Bd. iv, Abth. 2, S. 1-54.

account of their small size, they are only visible when they keep close to the surface of the disc, the figure of which their course sufficiently accurately represents; but where the hollow is deep and begins suddenly at the periphery of the disc, particularly if it extends laterally beneath the sclero-choroidal foramen, the disposition of the large veins is strikingly significant. The change of direction which the vessels small or large experience as they mount from the depressed optic disc and pass over to the retina, indicates the difference of the levels, the suddenness and extent of the deviation being a gauge of the steepness and depth of the hollow. Where the excavation is considerable, the veins at the optic disc deviate so widely from their prolongations upon the retina, that these two portions of the same vessels seem to be disconnected and laterally displaced; the calibre of the veins in the optic disc is also smaller than that of their continuations in the retina. The distance which the vessels at the bottom of the hollowed optic disc are out of focus, when those at the margin are in focus, is another measure of the depth of the hollow. A person looking at a hollowed optic disc for the first time with difficulty persuades himself that he is not looking at the outer surface of a sphere instead of into a cup, so deceptively does the hollow simulate a projection. This illusion results from a particular disposition of light and shade. The bottom of the hollowed optic disc reflects most of the incident pencils of light in the direction of the observer, and therefore shines brightly; but the pencils incident on the margin of the hollow for the most part do not return to the observer, and hence this seems to him less intensely illuminated, so that the bright centre of the disc is surrounded by a circular shadow. It is this which gives the idea of projection. A slight side movement of the object lens or speculum, by shifting the spot of most intense illumination, will dispel the illusion.

The gently sloping hollow is due to simple wasting of the nerve tissue, cases of cerebral amaurosis furnish good examples of it; but the abrupt excavation is significant of pressure, it

reaches its greatest extent in glaucoma. A peculiar form of excavation of the optic disc in which one-half of the sclero-choroidal foramen is undermined, whilst the opposite half is effaced, will be described in connection with sclero-choroiditis posterior.

Elevation, unnatural projection, of the optic disc in rare instances appears to depend on the presence of optic nerve fibres which have not lost their sheaths at the lamina cribrosa, but continue to retain them where they pass over into the retina. The greater thickness of these fibres increases the whole bulk of the optic disc and renders it unduly prominent. These thicker fibres, too, being less transparent, deaden the reflection from the lamina cribrosa, and incompletely mask the sclero-choroidal foramen, and in this way increase the apparent size of the extremity of the nerve-trunk. In the retina they form radiating greyish bands of variable length ending in faint brush-like tails.

Wasting of the outer strata of the retinal elements with preservation of the opticus fibres has been described by H. Müller as another cause of elevation of the optic disc; and a case in which the surface of the disc was projected by an earthy concretion has been recorded by this observer.

Inflammatory swelling of the intraocular extremity of the optic nerve in connection with cerebral tumours has been observed by v. Græfe who has published cases of this kind. The appearances noticed are a reddish-greyish opacity of the optic disc, obscuration of the sclero-choroidal foramen and enlargement with varicosity of the veins. He thinks it probable that the inflammation is secondary to obstruction of the efferent circulation through the ophthalmic vein in consequence of pressure on the cavernous sinus.*

* V. Græfe. Ueber Complication von Sehnerven-Entzündung mit Gehirnkrankheiten. Archiv. F. Ophth. Bd. vii. Abth. 2, S. 58.

3. MORBID CONDITIONS OF THE OPTIC DISC ATTENDED WITH VARIATIONS OF COLOUR.

Anæmia.—In determining the significance of colour-changes of the optic disc, regard should always be had to the colour of the surrounding fundus, because the colour of the optic disc is modified by its contrast with that of the fundus. Simple anæmia of the optic disc shows itself by a corresponding pallor, the nerve-tissue retaining its transparency so that the large vessels continue to be visible at some distance from the surface of the disc. The pallor of the nerve-tissue renders the veins very conspicuous, frequently making them appear larger than they really are. The whiteness of a simply anæmic optic disc is dull, and not glistening as the tendinous whiteness of atrophy. The best, uncomplicated examples occur in extreme general anæmia.

A very rare cause of anæmia is the obstruction of the retinal artery by an embolus. The supply of blood to the optic disc and retina is suddenly cut off. The branches of the artery are empty and contracted; the veins, too, are contracted, they contain but little blood and this only at intervals, intermediate portions being empty. The extremity of the nerve is blanched. One case probably of this kind has come under my own notice, but the patient neglected to present himself for the purpose of having a drawing and memorandum taken of his case. He was a middle-aged labourer, had valvular heart-disease, and came to the Royal London Ophthalmic Hospital on account of sudden blindness of his right eye. All the branches of the retinal artery were empty, contracted, and thread-like; and the veins were generally collapsed, but contained at irregular intervals small broken cylinders of blood. The fundus of the left eye was quite natural. A case of this kind has been recorded by v. Græfe.*

* V. Græfe. Ueber Embolie der Arteria centralis retinæ als Ursache plötzlicher Erblindung. Archiv. F. Ophth. Bd. v. Abth. 1, S. 136.

4. ATROPHY OF THE OPTIC DISC AND RETINA.

The atrophied optic disc is known by its peculiar tendinous or pearly whiteness. This is mainly due to the relatively large quantity of connective tissue present, which is partly the product of a fibroid degeneration of the nerve tissue; and in part consists of the connective frame that previously supported the bundles of nerve fibres, and that springs from the inner division of the nerve-sheath, and is continued through the lamina cribrosa to the membrana limitans; in addition to this there is the lamina cribrosa itself, a tendinous web drawn from the inner third of the sclerotica. The fatty and earthy matters resulting from the atrophy of the nerve tissue, entangled amongst this fibroid tissue, add to the pearly whiteness of the optic disc. The retinal arteries and veins are small, or some branches are obliterated.

In consequence of its whiteness the atrophied optic disc is very conspicuous. Its outlines at first sharp, subsequently lose their distinctness and become ragged; and its surface becomes depressed. Old cases of cerebral amaurosis furnish good studies of these appearances.

Case.

M. A. H——, æt. 24, in July, 1858, whilst standing in the sun with her head uncovered was suddenly seized with violent pains in the temples. On the second or third day after this, the pain extended to her neck and shoulders, she then fell from her chair in an epileptic fit. This was followed by hemiplegia of the left side, diplopia and rapid failure of vision, so that fourteen days afterwards when she came under my notice, the retinæ were quite insensible to light. At this time I could detect nothing abnormal in the fundus, but on a second examination, made December 16, 1859, I found the retinal vessels very much diminished in calibre, and the optic nerve-entrance was pearly white and sunken.

5. HYPERÆMIA AND INFLAMMATION.

(PLATE I, FIG. 2.)

Capillary congestion first shows itself as a minute pink stippling limited to a segment, or overrunning the whole of the optic disc. As the distension of the vessels proceeds, the minute dots and streaks blend in a uniform blush which invades the centre of the disc last. As the redness of the disc increases its contrast with the adjacent fundus diminishes, and its outline becomes inconspicuous, or lost to view, in which case the confluence of the large retinal vessels alone marks its situation. These vessels seem to end abruptly at the surface of the optic disc, the redness and the opacity of the nerve tissue concealing their deeper vertical portions from view.

The retina, unlike the optic nerve, is not reddened by simple capillary congestion, the reason being the largeness of the meshes of its capillary net. Its arteries are but little prone to enlargement, or varicosity, and they readily elude notice; but its veins become very swollen and tortuous, and as they lie at different depths in different parts of their course, and are, therefore, overlaid by a greater or less thickness of retinal tissue, they appear in different degrees of distinctness. Thus the convex bend of a vein, which comes close to the inner surface of the retina is plainly visible; whilst the continuous portions of the same vessel, as they dip away from the surface toward the middle retinal strata, become indistinct and tapering, or wholly hidden, and this gives the veins the appearance of being interrupted.

The saturation of the retina with serum by reducing its transparency produces these appearances, and the presence of more opaque inflammatory products still further intensifies them. The degree of concealment of the deeper portions of the veins is a measure of the extent in which the transparency of the retina is diminished, and in this way is a clue to the quantity and nature of the inflammatory effusion. But we possess another

gauge in the degree in which the choroidal coloration of the fundus is damped, because the view of the choroid is obscured in proportion to the opacity of the retina. A little serum which only produces a faint haziness of the retina, but slightly flattens the brightness of the choroid; whilst dense inflammatory products so cloud the retina that the choroid but dimly glimmers through it, or is wholly lost to view. In this state the retina has a dull grey or stone colour, blotched with rusty patches, where capillary hæmorrhage has taken place. These changes in the retina are accompanied with a cloudiness of the vitreous humour, which is greatest in the parts bordering on the retina, and decreases towards the centre of the humour.

The following forms are distinguished :—

1. Retinitis characterized by intense redness of the optic disc, great venous congestion, œdema and capillary hæmorrhage, little tendency to deposition of lymph, and little loss of transparency of the retinal tissues or of the vitreous humour. Ret. simplex, ret. apoplectica. Capillary apoplexy of the retina.

2. Retinitis with less vascular turgescence, but with free infiltration of the retina and adjacent vitreous humour with lymph, and correspondingly great opacity. As the syphilitic and strumous retinitis.

3. Suppuration of the retina.

Retinitis ends in resolution and recovery, or in atrophy. Where the former occurs the distension of the swollen veins subsides, the spots of capillary hæmorrhage disappear, fading from the edges towards the centre; the inflammatory products are removed, the transparency of the retina returns, and the details of the choroid are again sharply seen. The redness of the optic nerve is often last to disappear. The veins frequently retain their tortuosity, and with this exception the fundus preserves no traces of the previous inflammation. This fortunate termination commonly occurs only in the first of the above three forms of retinitis. In the second form, complete recovery occurs only where the

exudation has been in limited quantity, and the inflammation has been arrested before the retinal tissues have suffered much. In a very large proportion of cases of this form atrophy ensues, and when the vitreous humour has become sufficiently clear to allow the optic nerve to be seen, this is found shrunken, oval, or otherwise distorted, with a ragged jagged border; or it is no longer distinguishable. Branches of the large retinal vessels are observed to be obliterated, traces of them remaining in the form of thread-like lines; other branches have wholly disappeared. The fundus is blurred, the choroid is confused, or wholly hidden by patches of retina, of a peculiar opalescent yellowish white colour, in a state of fatty disintegration.

The third form of retinitis, the suppurative, always ends in destruction of the eyeball.

6. RETINAL HÆMORRHAGE.

(Plate II, Fig. 1.)

With few exceptions, hæmorrhage, not produced by mechanical violence, proceeds from the capillary vessels. The extravasated blood occurs in spots and streaks, the figure being probably determined by the arrangement of the tissues amongst which the blood is poured out. Thus, if a vessel lying amongst the opticus fibres were to burst, the blood would most readily escape along the nerve bundles, and form streaks, because there is least resistance to its path in this direction; whilst blood effused in the grey nervous or granular layers, which have no fibrous texture, would spread equally in all directions, and form circular spots; again, an extravasation under the membrana limitans extends laterally, or bursts through it into the vitreous humour. The capillary apoplexies are, perhaps, more numerous behind than in front of the equator; they are scattered, or crowded, in which case neighbouring ones run together into patches of considerable size. Fresh blood-spots have a rich

crimson colour, deepest at the centre and fading off towards the edges; older ones are blacker, or brownish-red, rusty, or buff. The effused blood is either completely removed, leaving no trace of its former presence, or, what is much more frequent, in the sites of former apoplexies, the fundus retains a confused patchy appearance.

In many dissections I have found the capillaries lengthened, curled, and studded with small globular and fusiform saccules, miniature aneurisms, by the bursting of which the hæmorrhages occur. These alterations in the capillary walls are not preceded by fatty or other apparent structural changes. Where hæmorrhage has occurred, the ruptured saccule, the vessel on which it is seated, and the tissues for some space around, are found gorged with blood-corpuscles; these, with the lacerated retinal tissues, wither, giving rise to the formation of large granular corpuscles; and the hæmatine generally collects in orange-red beads and nodules.

The occurrence of retinal hæmorrhage is announced by a sudden obscuration of vision, varying in kind and degree with the extent and locality of the clot. The external aspect of the eye may be healthy.

CASE.

A hale old countrywoman, whose sight had always been excellent, awoke with her left eye nearly blind; it was neither painful nor red, nor distressed by light. Five weeks afterwards she came under my care at the Royal London Ophthalmic Hospital. The left pupil was larger than the right, and sluggish. At a few inches she dimly recognised the outline of my hand.

OPHTHALMOSCOPIC SIGNS.—Numerous spots and streaks of effused blood in the retina behind the equator, confluent around the posterior pole of the fundus in large blotches which completely hide the optic nerve-entrance. Fine striæ in the margin of the lens. Seven weeks afterwards most of the effused blood had disappeared; the optic nerve-entrance had become visible; the hands of a large clock were recognised across a wide room. At the expiration of five months scarcely any of the blood was left; where it had been the retina was slightly opaque and mottled. No. 12 (Great Primer) type could be read.

CASE.

A street-hawker, under my care at the Royal London Ophthalmic Hospital,

for slight conjunctival inflammation, was struck on the left eye by a potatoe, which was thrown with great force, as the woman was stunned and fell. When the swelling of the lids had subsided so that the state of the eye could be ascertained, the retina was found to be quite insensible. The pupil was pear-shaped, dilated, and motionless.

Ophthalmoscopic Signs.—A large diffused patch of extravasated blood occupied the inner half of the retina behind the equator. The entrance of the optic nerve and the retina were congested.

The blood was ultimately absorbed, but the retina never regained its sensibility, and vision was not restored.

No case in which I could trace a hæmorrhage to a ruptured artery has come under my observation, but I have seen a few cases where a large vein was the source of the extravasation. The following is one of them :—

Case.

A stout, hearty-looking countrywoman, on rising on a winter's morning was startled by a redness of the flame of her candle, and by the darkness of her room. By a separate trial of each eye she found that in the left, vision was nearly gone. Seven weeks afterwards, when she first came under my care at the Royal London Ophthalmic Hospital, she could only distinguish between a blank and a printed sheet, but could not recognize the largest type. The external appearance of the eye was healthy, and the pupil was active.

Ophthalmoscopic Signs.—A large patch of extravasated blood, having the shape of an inverted cone, at the outer side of the optic nerve-entrance, occupying the position of the yellow spot. At a short distance above, and parallel to the base of the cone of blood, which was a sharp straight line, there ran a large retinal vein; this part of the vein was empty and collapsed, but its continuation on either side was patent and filled with blood. The depending apex of the cone expanded into a disc, at the centre of which a glimpse of the natural colour of the fundus was visible. The appearance was as if a large drop of blood had trickled down from the vein.

The effused blood was slowly absorbed, the fundus resumed a natural aspect, but the collapsed portion of the vein was obliterated. Vision was restored to its former integrity, the woman reading No. 2 (Pearl) type fluently.

When blood escapes from the retina into the vitreous humour it is very slowly absorbed. The clots, as seen with the ophthalmoscope, have not the crimson colour in which they appear by reflected light out of the eye, but are dark, or even

nearly black, in consequence of the small amount of light that they reflect affecting the observer's retina much less sensibly than the flood of light which sweeps past the clots from the fundus around.

CASE.

A. H——, a farm servant, æt. 21, who said his health had always been good, had a sudden obscuration of the right eye whilst at work. The mist, which was at first not dense, increased, so that perception of objects was quite lost. Six months after this he came to the Royal London Ophthalmic Hospital. The pupil was active. The outward appearance of the eye was good.

OPHTHALMOSCOPIC SIGNS.—The retina and choroid could not be seen. The upper hemisphere of the vitreous humour contained a grey cloudy floating film, with small brown flocculi below it. Whilst still lower than this, between the equator and ora serrata, there was a large dark mass, which when obliquely illuminated had a deep crimson colour, and was evidently a large blood clot.

CASE.

E. M——, æt. 21, a gardener was admitted to the Royal London Ophthalmic Hospital.

Three months previously, whilst stooping to clip a box-row, his right eye was obscured to such a degree that he could not discern objects. I could not discover anything wrong in the external appearance of the eye. The retina was just sensitive to light.

OPHTHALMOSCOPIC SIGNS.—Extensive retinal apoplexies hiding the entrance of the optic nerve, and large clots in the vitreous humour.

7. DETACHED RETINA.—FLOATING RETINA.—HYDROPSIE SOUS RETINIENNE.

(PLATE II, FIG. 2.)

The detachment of the retina from the choroid, and its displacement inwards towards the axis of the globe, has been shown by the ophthalmoscope to be of frequent occurrence. Old and extensive displacements are very striking objects, but

slight and recent ones may escape the notice of an inattentive examiner.

When raised by serum, the detached retina projects into the vitreous humour in the form of a bluish or greyish vesicle, tense or folded, undulating from the communicated movement of the eyeball, and displaying the ramifications of the retinal vessels. These vessels present frequent apparent interruptions, not from an arrest of the circulation, but from their alternating appearance and concealment as they run over and between the folds. The limit of the detachment where the separated retina joins that which is in position, is indicated by a sudden bending of the vessels as they spring from one to the other, as well as by the contrast between the normally coloured fundus and that where the image of the choroid is damped, or wholly obscured by the detached retina and the serum behind it. At first the natural transparency of the retina is only slightly diminished, and the ruddy colour of the choroid glimmers through; but in the course of time the retina becomes opaque, and the choroid is no longer discernible.

A retina which has been long detached is pearly white, but this colour may be modified by the admixture of blood with the serum which is behind; and in rare cases it glistens with cholesterine.

It has been very generally thought that the detachment always begins at the lowest part of the fundus, near the equator, and it may be safely said that it is generally first observed in this locality; but the possibility always remains that the fluid beneath the retina, at this part, has merely gravitated here, having been originally poured out at a higher part of the fundus. This is supported by a case in which I observed the subsidence of a portion of detached retina lying above the optic nerve-entrance, simultaneously with the appearance of a fresh detachment below the nerve, at the equator. Similar cases have been recorded by v. Græfe, and it is probable that the occurrence would often be noticed if cases of detached retina generally

came under our notice at an early stage; but this does not commonly happen, for the separation creeps on so insiduously, being unattended with pain or any external signs of mischief, that sometimes the lower hemisphere of the retina is stripped off from the choroid before the patient is aware that anything is wrong with his eye; and indeed the discovery is sometimes made accidentally by closing the sound eye.

A mutilation of the field of vision corresponding to the size and situation of the detached portion of retina is the first indication. Where the detachment occupies the lowest part of the fundus, objects lying in the upper part of the field of vision are not seen, so that the field is cut through by a horizontal line, which is more commonly sinuous than straight. This limit is not quite abrupt, for there is a band answering to the junction of the floating and unseparated retina, within which the perception of objects progressively fades out.

In some cases the separation of the retina remains stationary for a time, but in others it proceeds steadily until the whole tunic is stripped from the choroid, and thrown towards the axis of the globe in the form of a funnel, slender and tapering towards the optic foramen, and expanding along the line of the ora serrata. When the coarctation is very great the retina traverses the axis of the globe as a slender cord, which I have known to be mistaken for a persistent hyaloid canal.

The objects which inexperienced observers commonly mistake for detached retina are waving films of opaque hyaloid membrane, or decolourized blood-clots floating in liquefied vitreous humour; their nature is negatively determined by the absence of the retinal vessels. Where cancer of the choroid has produced retinal detachment, and this I have often seen in dissections, the nature of the original disease is for a time masked.

INTRA OCULAR CHANGES OCCURRING IN KIDNEY DISEASE.

The frequent occurrence of amaurosis in the advanced stages of kidney disease has long been recognized, but the structural changes in consequence of which the retina becomes insensible to light, have only recently been begun to be studied. The subject is one very difficult to investigate, and which has already given rise to much controversy; for what is known of it we are almost wholly indebted to German authors. The connective tissue forming that system of fibres which run from the membrana limitans to the rods and bulbs, the radiating fibres, undergoes thickening, fatty degeneration, and a peculiar hyaline transformation which has been designated sclerosis. The thickening and sclerosis are most conspicuous in the inner ends of these radiating fibres, the fatty degeneration in the outer ends. (To obtain a good view of these fibres vertical sections of the retina, previously hardened in a solution of chromic acid, should be made at right angles to the optic nerve fibres.) An abundant formation of capillaries is described in the optic papilla, they are little prone to fatty degeneration, but are liable to sclerosis, and to rupture. The changes which have been observed in the nervous tissue consist in the formation of large granular corpuscles in the granular layers, and a very singular transformation of the nerve fibres. These become expanded at intervals into large knots, which so deceptively resemble ganglion cells that much difference of opinion has existed concerning their real nature. In isolated nerve fibres swellings of all sizes may be seen, from those which only slightly exceed the common varicosities, to those which equal in size a large ganglion cell. These knotty swellings, when abundant, are closely packed in the meshes of the radiating fibres, as in nests. Fatty degeneration and sclerosis of the choroidal vessels have been observed. The

cells of the vitreous humour, particularly in the neighbourhood of the retina, are said to be hypertrophied.

The ophthalmoscopic signs are congestion, hemorrhage, and slight haziness of the retina. This opacity increases the apparent size of the optic disc by confusing its outlines, and renders the vessels less distinct than natural. These seem to terminate taperingly at the surface of the optic disc, beneath which they cannot be followed. Small bright yellowish-white dots appear in the opaque retina, at first thinly scattered, but becoming confluent. They form large patches, which ultimately coalesce and overspread a considerable extent of the retina with a whitish opacity, the uniformity of which is broken by blotches of effused blood.

Literature of this disease :—

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Ueber die Amblyopie bei Nierenleiden mit Herzhypertrophie, von Dr. C. Schweigger. A. F. O., Bd. vi, Abth. 2, s. 295.

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IV.

THE CHOROID.

1. HYPERÆMIA.

The opthalmoscopic signs of hyperæmia are,—increased redness of the fundus, and dilatation and varicosity of the larger choroidal vessels, in particular of the veins. The deeper redness of the fundus is the collective effect of the turgescence of the choroidal capillaries, which even when swollen are not visible individually. In judging of the significance of this redness, regard should ever be had to the quantity of pigment present, and the appearances noted in one eye should always be compared with those seen in the other; and in determining on the existence of irregularities, the natural differences of size and distribution of the veins in different parts of the choroid should always be kept in mind, without which mistakes will frequently occur.

Owing to the paucity of pigment in the eyes of young and fair persons, deviations of size or distribution can be recognized without difficulty; but where much pigment is present, the condition of the vessels may be imperfectly recognizable, or even not at all.

Congestion of the choroid is of common occurrence. A sense of fulness and weariness, with pain, slight lachrymation and intolerance of light, are the usual symptoms; they vary greatly in degree amounting in some cases only to slight discomfort, whilst in others they are most distressing.

2. INFLAMMATION.

(PLATE III, FIG. 1 & 2.)

The signs which indicate the transition from simple congestion to inflammation, depend on the situation in which the inflammatory products are effused, on their quantity, and on their nature. The stroma of the choroid may be infiltrated and swollen, or there may be an effusion upon its inner surface, or the loose web which connects it with the sclerotic may be distended. A large escape of serum or of blood in the last situation insinuates itself between the choroid and sclerotic, loosens or even breaks the connection between these tunics, and pushes the choroid inwards. The same occurrence on the inner surface of the choroid upheaves and detaches the retina, which is thrust inwards, at the expense of the vitreous humour, towards the axis of the globe; a smaller quantity of serum effused in this situation soaks into the retina without detaching it from the choroid. More rarely the products of inflammation burst through the retina into the vitreous humour, or diffuse themselves between the membrana limitans and the hyaloid membrane, as I have verified by dissection.

A small quantity of but slightly turbid serum, soaking the stroma of the choroid, confuses the details of this tunic, and prevents their distinct appreciation with the ophthalmoscope, casts a faint haze over the fundus, and damps its redness. The positive determination of the precise seat of a slight exudation is not always easy, and in some cases is impossible. Where the retina continues transparent, so that its veins are sharply seen in front of the opacity, it is presumable that this lies upon the inner surface of the choroid, or within it. Perhaps, as a general rule, exudations in the retina are greyer and more translucent than those in the choroid, which are frequently whiter and have more body. Where the effusion consists principally of lymph, even though the whole quantity be small, the opacity is much greater than that caused by serum alone.

The common occurrence of capillary apoplexy, which some authors describe in choroiditis, is against my own experience, except in the suppurative inflammation of the choroid which begins with embolia, and rapidly involves the whole eyeball. Where the retina has been stripped from the choroid by an abundant discharge of serum, this is frequently stained with blood, and sometimes contains coagula of considerable size; here it is probable that the blood has flowed from the lacerated retinal vessels and not from those of the choroid. Generally, capillary apoplexies of the choroid are more diffuse and less sharply defined than those in the retina; they form spots of a dull crimson, which pass through various shades of rust and brown, and sometimes leave permanent traces in atrophy of the chorio-capillaris and of the pigment epithelium.

The intimate relation between the choroid and the retina leads to the speedy extension of the inflammatory process to this tunic. The vitreous humour also soon becomes hazy, either by transudation of the inflammatory products through the retina, or rarely from a direct influx through disrupture of this tunic; the opacity is always greatest in those parts which are contiguous to the inflamed choroid.

Where perfect recovery takes place, which probably only occurs where the effusion has been slight, serous rather than plastic, and within the choroid rather on its inner surface, the haziness of the fundus clears off, its normal colour returns, and the texture of the choroid is again perceptible.

Very generally recovery is less complete, the tissues which have been inflamed undergoing atrophy. The regularity of the choroidal epithelium is broken, its pigment cells disappear in great part, or completely, from the foci of inflammation, so that the inner surface of the sclerotic comes into view unmasked by pigment, forming brilliant yellowish white figures, which are bordered with black fringes, just as if the pigment had been scraped off the figures and transferred to the parts immediately bounding them. These disturbances commence in the epithelium

at an early period, so that before the fundus clears the black pigment flocs are dimly seen. The undeviating course of the retinal vessels across these white figures shows that they are not raised nor sensibly depressed, and distinguishes them from ectasiæ on the one hand, and from the less sharply circumscribed, more yellowish, raised patches of choroid, infiltrated with solid exudation, on the other.

These solid deposits either undergo fatty degeneration, and disappear more or less perfectly, or they are transformed into fibroid tissue, in which case the choroid is seamed with bluish-white pearly scars, and this scar-tissue is prone to ossification. I am not aware of any recorded cases in which the ophthalmoscopic recognition of such bony scales in the living eye has been confirmed by dissection; but I have seen remarkably defined white patches on the inner surface of the choroid, covered by an attenuated wasted retina, which I have little doubt were osseous.

The ophthalmoscopic signs of inflammation simultaneously appear over the whole choroid, or they are restricted to a few limited patches of large size, or they start up in a number of small isolated spots. Cases of the last kind have been distinguished by the title C. disseminata. The inflammatory foci, small and circumscribed, usually first appear at some distance from the optic disc, more rarely in its immediate neighbourhood. They are characterized by a faint haze of the fundus, a blurring or total obscuration of the choroidal image, and by intensified coloration of the fundus between the spots. These signs are soon replaced by those of atrophy; as the exudation is removed, the haze of the fundus clears off, the choroidal epithelium is found wanting, and the sclerotic is visible, bordered with a black fringe. The spots of inflammation become more numerous, neighbouring ones run together, and in this way large segments of the fundus may be overspread.

It is a matter of common experience, that limited inflammation of the choroid often runs its course without any notice of its presence being furnished by the external appearance of the

eye; in other cases a slight pinkness of the ciliary region, fulness of the efferent ciliary veins, and sluggishness of the pupil are the only objective phenomena, but here the ciliary processes are implicated.

3. ATROPHY.

(Plate III, Fig. 1.)

Besides the atrophy of the choroid which has been described in connection with inflammation, other forms occur, and of these the most common is a simple deficiency of the pigment of the epithelium, and, in a less degree, of that in the multipolar cells of the stroma. In consequence of this the colour of the choroid is less intense, and its veins are more plainly seen. This is a frequent senile change.

Another very frequent form of atrophy is that associated with colloid deposit upon the elastic lamina; though common in advanced life, I have often met with it in shrunken eyes of young persons. The elastic lamina which intervenes between the epithelium and the chorio-capillaris, becomes thickened by the accretion of a homogeneous glassy substance, which in its physical and chemical properties resembles the elastic lamina itself. When the colloid substance is deposited upon the inner surface of the lamina, it forms bosses and conglomerate masses of glassy globes, which disturb the exquisite regularity of the epithelium, thrusting aside its cells, and projecting into the retina. These compound masses are plainly visible to the unaided eye, and should, therefore, be easily recognized with the ophthalmoscope in the living eye, but I am only aware of a single case, published by Liebreich, in which this has been done. The disturbance of the epithelium is the clue, but the diagnosis has yet to be satisfactorily laid down.

When deposited on the outer surface of the elastic lamina the colloid substance is sometimes moulded in the meshes of the

capillary net, of which, when the lamina has been successfully isolated, it presents an exact cast. In such cases the capillaries channel the glassy mass.

The coats of the larger vessels become thickened by the intersticial deposit of colloid and undergo a progressive diminution of calibre, which may proceed to complete obstruction.

In the advanced stage the colloid substance becomes impregnated with earthy salts, and has a granular or translucent appearance like horn. At this time the epithelium displays marked signs of atrophy.

V.

CHOROIDO-RETINITIS PIGMENTOSA.

There is a peculiar form of choroido-retinal inflammation which characterizes itself by commencing near the ora-serrata, from which it creeps backwards towards the optic disc, and by the extreme slowness of its progress. Its ophthalmoscopic signs are those of atrophy, and the inflammatory nature of the process rests on microscopical dissections rather than on the appearances observed during life. In these cases the choroid and retina are attenuated, and unnaturally adherent to each other, so that if the retina is peeled off the choroid the separation is not clean, and shreds of choroid remain on the outer surface of the retina.

The elementary tissues of the retina and choroid are in a state of atrophy, which is less advanced in the inner layers of the retina, than the outer, of which traces only remain. Amongst the withered retinal tissues scattered grains and clusters of pigment are found, the colour and grouping of which indicate the choroidal epithelium to be its source; the appearances give the idea that the pigment has been swept from the choroid into the

retina by a strong current. It occurs in greatest abundance along the larger retinal vessels which lie near the inner surface of the retina, but which in consequence of the disappearance of the outer layers are brought into close proximity to the choroid.

The ophthalmoscopic signs are black specks and flocs of every conceivable shape, at first scattered, but subsequently as they become more abundant, running together into a tangled web, the stronger lines of which often accompany the retinal vessels which are much reduced in size. The choroid in the meshes of this web is poor or wholly deficient in pigment. These signs first appear near the ora-serrata, spread very slowly backwards, and finally those of atrophy of the optic nerve are superadded.

Coincidently with the progress of the atrophy towards the posterior pole of the fundus, a centripetal narrowing of the field of vision occurs, but as objects lying in the centre of the field continue to be distinctly seen, the shrinking of the margin often escapes notice, until the size of the field is considerably reduced. When it has become very small night-blindness occurs, apparently from inability to acquire a general idea of the relative positions of surrounding objects, which is required for walking at night, more than a sharp perception of objects separately. The progress of the disease may extend over several years, and sometimes remains stationary for a long period. It is not until late that the centre of the visual field deteriorates, which happens when the atrophy approaches the centre of the retina.

Nothing is learned from the outward aspect of the eye, until amblyopia occurs, when the pupil becomes large and sluggish.

CASE.—CHOROIDO-RETINITIS PIGMENTOSA. CENTRIPETAL CONTRACTION OF THE FIELD OF VISION.

G. C——, æt. 37, sallow, in broken health, whose sight had been slowly failing for two years, and this without pain or external redness, sought advice at the Royal London Ophthalmic Hospital, December 6th, 1860. The right eye with difficulty discerned letters in No. 15; the left could merely distinguish a printed from a blank page, and indistinctly recognized my fingers held at a few inches distance. The left pupil was dilated and almost motionless, the right

about medium size and inactive. The field of vision of each eye had greatly shrunk. The greatest dimensions of the right field, measured through the fixing point, were 15½ by 10½ inches, and those of the space where vision was relatively distinct, were only 5½ by 4½ inches. The ophthalmoscopic appearances in both eyes were similar; in front of the equator the choroidal pigment epithelium was generally absent, and the chorio-capillaris atrophied: the white sclerotic, thus exposed to view, was covered with an irregular black tracery. The optic nerve, and the retina behind the equator, were anæmic.

The occurrence of this disease in members of the same family and in successive generations, favours the opinion of its hereditability, but it has not been fairly connected with any particular diathesis.

VI.

SCLERO-CHOROIDITIS POSTERIOR.—POSTERIOR STAPHYLOMA.

(Plate IV, Fig. 1.)

Staphyloma of the posterior pole of the eyeball is perhaps the most easily recognizable of all the deep diseases, in consequence of its ophthalmoscopic signs being very conspicuous and limited to the region of the optic nerve.

It makes its appearance as a narrow whitish crescent closely embracing the nerve-entrance, usually the outer side, rarely the inner, and only exceptionally the upper or lower. The corresponding portion of the sclero-choroidal ring is blurred and indistinct. The outer border of the crescent is sharply defined, its outline is slightly ragged; and the choroidal epithelium in its immediate neighbourhood is unequally pigmented. The crescent enlarges by extension of its outer border which is sometimes indented, in some cases so much so that the crescentic figure is lost; at the same time the optic nerve-entrance becomes more involved in the figure, till in extreme cases it is entirely included

in it. Occasionally small white spots with excessive pigmentation around them appear in the neighbourhood of the crescent. The retinal vessels pass from the optic nerve-entrance across the white figure to the fundus beyond, and when the staphyloma is deep, indicate by their winding course the protrusion of the ocular tunics. The yellowish-white background throws up the vessels and gives them an apparent enlargement, whilst where they pass from the white figure on to the deeply coloured fundus, to an inattentive observer they sometimes seem to disappear; this also is illusory, and merely the effect of the dark background. Within the white figure large choroidal veins are sometimes seen. The optic nerve-entrance when cursorily examined appears to have an oval outline, where the white crescent is of moderate size; for the confusion of that segment of the sclero-choroidal ring which lies between the nerve and the crescent, leads to an apparent blending of the two figures. Where the staphyloma is deep the corresponding part of the sclero-choroidal ring is nearly, or quite effaced, and the nerve is wasted so that its surface slopes uninterruptedly into the hollow of the staphyloma; where this has occurred, owing to the altered perspective under which it is seen, the figure of the nerve-entrance is an ellipse with the major axis vertical, and the vessels seem to pierce it near the inner side.

At an advanced stage of the staphyloma, floating films are seen in the vitreous humour denoting liquefaction of this organ; and in adults capillary hemorrhage occasionally occurs in the retina. In persons of broken habit, past middle age, I have seen a few exceptional cases end in acute inflammation of the globe.

Dissections have shown that the white crescentic figure is the inner surface of the sclerotic corresponding to the staphyloma, and that at this part all the coats of the eyeball are attenuated. The choroidal epithelium is absent, the chorio-capillaris withered. The outer layers of the retina overlying the crescent are atrophied, but the inner ones, particularly the

opticus fibres long preserve their integrity; as a consequence of this, the retina at this part is incapable of receiving sentient impressions, but is able to conduct impressions from more distant parts to the optic nerve. This insensibility is shown by the increase of the blind spot which corresponds pretty exactly to the optic nerve-entrance plus the crescent.

Posterior staphyloma is the commonest cause of myopia, the degree of which is proportionate to the elongation of the globe. In the advanced stages when the yellow spot is involved in the staphyloma, and the optic nerve wastes, amblyopia is superadded to short-sight.*

CASE.

Mary P——, æt. 40, a thin, weak, highly nervous woman, first came under my notice at the Royal London Ophthalmic Hospital, October, 1857. At that time her right eye was myopic and amblyopic; she could only recognize large objects with it, and this indistinctly; a concave lens gave positive, though but slight improvement. An elongation of its antero-posterior axis was observed when the eye was strongly converged; this was due to a slight conicity of the cornea, the apex of which was nebulous, to an extension of the ciliary region, and to a posterior staphyloma indicated by a white crescentic figure, embracing the outer side of the optic nerve-entrance. The subconjunctival veins were varicose. The globe was slightly tense. The lens had been extracted seventeen years previously. The right eye was also myopic, and had a similar but smaller staphyloma at the outer side of the optic nerve-entrance.

I next saw her in the spring of 1859, when the left eye was very congested, hard, and painful, and its sight was quite extinct. As it was quite lost, and her right eye seemed to be distressed by it, I advised enucleation, which she declined. She returned to the Hospital April 17th, 1860, with intense congestion and great hardness of the left eye-ball, chemosis of the conjunctiva bulbi, a deep ragged ulcer of the cornea, and the large anterior chamber distended with turbid serum. The pupil was obstructed. She suffered great pain in and around the eye.

Her right eye soon tired, and became painful, and it had muscæ. The greatest breadth of the posterior staphyloma in this eye equalled half the diameter of the optic nerve-entrance. The retinal vessels were small. The vitreous humour was hazy, and contained floating gauzy membranes. A-6″ lens enabled her to read large type, and to recognize distant objects.

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* I have seen a few rare cases where the course and the different levels of the retinal vessels unmistakably pointed to the presence of a protrusion of the back of the eyeball, but where there was no white figure, the uniformity of the choroidal epithelium being only slightly disturbed.

Her left eye gave her so much distress, that she now came to beg me to remove it, which I did by enucleation in our customary manner.

Dissection.—Its antero-posterior axis measured 14¾ lines, its greatest transverse measurement was 9½ lines. This great elongation of the globe was mainly due to a staphylomatous extension of the posterior half, which reached backwards 1½ lines behind the insertion of the optic nerve, which was at the inner side of the staphyloma. The condition of the cornea has been already noticed. The sclerotic, anteriorly, had a natural thickness, but at the posterior staphyloma it was three times thicker than at the corresponding point on the opposite inner side of the optic nerve. This extreme thickening was due to an excessive vascularity chiefly of its outer layers, to an unravelling and separation of its fibres by a copious effusion of serum, and by large nets of exudation corpuscles. The iris was tough and much thickened by parenchymatous exudation, its anterior surface was coated by a tough false membrane which stretched across and perfectly closed the pupil. The ciliary body was also infiltrated with exudation corpuscles and serum, and greatly thickened. The longitudinal, and oblique bundles of the ciliary muscle were distinctly traceable; they had a granular dark appearance, and their nuclei were few and indistinct. The choroid everywhere preserved its relations with the sclerotic and retina; its stroma was distended with exudation corpuscles and serum; the stellate pigment cells were scattered, and in parts wholly absent; the elastic lamina was unchanged, and everywhere continuous, the hexagonal epithelium was unbroken, but the cells were swollen and ragged. These changes in the choroid reached their maximum at the posterior staphyloma and gradually decreased towards the ora serrata. The retina was opaque, and at the centre of the posterior staphyloma had a maximum thickness of 1½ lines, becoming gradually attenuated towards the nerve-entrance, and towards the ora serrata. The radiating fibres, enormously stretched, and widely separated, formed the most conspicuous object in the field of the microscope. Some of them were transparent, had bright, sharp, even outlines, whilst others were swollen and opaque, had softer outlines, and were varicosely enlarged. The elements of the inner and outer granular layers were withered and scattered, the ganglion cells were also atrophied. The opticus fibres were granular and dark, but they had no double outline and were not thickened. Only a few traces of the rods and bulbs were visible. The vessels were atrophied. The whole retina was charged with exudation corpuscles and much granular molecular matter, yet its stratification was nowhere wholly lost. At one point of the staphyloma the retina and sclerotic appeared to the unaided eye to be directly continuous through a breach in the choroid; the three tunics were here very firmly adherent, and the hexagonal epithelium of the choroid was absent, but the elastic lamina was continuous.

The optic nerve was atrophied. Its inner side deeply excavated and undermined, was over-hung by the projecting margin of the sclero-choroidal foramen; its outer side gently sloped into the staphyloma. The bottom of the cup was formed by the lamina cribrosa, and festooned by the attachment of folds of hyaloid membrane which converged towards it. The hyaloid capsule

was partially separated from the membrana limitans by a thin stratum of exudation. The vitreous humour formed a solid milky mass, friable at the centre but tougher externally.

It, too, was infiltrated with exudation corpuscles, and traversed by a tangled web of intricately interlacing fibres resembling those found in coagulated fibrine; the corpuscular elements were most plentiful centrally, and the fibrous abounded externally in the tougher portions. The corpuscles were formed endogenously in large brood cells, some of which contained as many as four, five, and six of them; these brood-cells were certainly connected with hyaloid membrane, and were, I believe, metamorphoses of its persistent nuclei. The shrunken remains of the torn capsule of the lens were glued in a compressed mass to the back of the iris. The ciliary processes were coated by a tough laminated deposite, moulded in the canal of Petit.

CASE X.—CILIARY AND POSTERIOR STAPHYLOMA OF THE LEFT EYE. ENUCLEATION AND DISSECTION. POSTERIOR STAPHYLOMA OF THE RIGHT EYE. MYOPIA AND AMBLYOPIA.

Mary Ann W——, a pale, delicate girl, æt. 19, deeply scarred by the small-pox, was admitted into the Royal London Ophthalmic Hospital, September 20th, 1859. Her left eye, which for several years had been quite blind, was much enlarged, and her personal appearance was so greatly disfigured by it, that she was unable to obtain employment. The ciliary sclerotic was elongated, thinned, bluish, and studded with a circle of small oval projections. The pupil, very small, irregular, and completely obstructed by a greyish membrane, was drawn towards the lower and inner part of the cornea, where there was an adhesion of the iris. At this point the cornea was opaque, and its surface was uneven. A chalky-white shrunken lens was visible through the partially closed pupil. I attributed the total blindness to wasting and excavation of the optic nerve-entrance. Her right eye was myopic, and slightly amblyopic. With a 3-inch lens she was just able to read No. 8, and to recognize, though imperfectly, large objects a few feet from her. The outer side of the optic nerve-entrance was clipped by a white crescentic figure, indicating a posterior staphyloma. As she was anxious to get rid of the disfigurement, and to wear an artificial eye, I enucleated the left eyeball, preferring this course to abscision of its front only, because its general enlargement, and the obvious signs of former sclero-ciliary and iritic inflammation, coupled with the presence of posterior staphyloma in the other eye, made me suspect the presence of a posterior staphyloma (which the obstruction of the pupil prevented me from verifying with the ophthalmoscope), as well as a fluid state of the vitreous humour; and I had seen on more than one occasion troublesome bleeding follow excision, where the posterior half of the globe was unsound. The conjunctival wound was drawn together with a fine silk stitch; it soon healed, and she left the Hospital in a few days with an artificial eye.

DISSECTION.—The antero-posterior diameter of the enucleated eyeball was 15 lines, and its transverse at the equator measured 12 lines. At the outer

side of the optic nerve there was a small hemispherical staphyloma nearly 2 lines in diameter, which projected $1\frac{1}{2}$ lines beyond the general curve of the globe. The vitreous humour was diffluent, but transparent. At the outer side of the optic nerve-entrance was a white crescentic figure which exactly corresponded to the staphyloma. Here the sclerotic was thinned, and the meshes of its fibrous tissue were loaded with oil globules. At this spot the choroid and retina adhered so firmly to each other, that I could only imperfectly separate them; the choroidal epithelium was absent; the multipolar cells of the stroma were few, and held but little pigment; the chorio-capillaris was atrophied. A thin layer of opaque nerve fibres passed from the optic nerve-entrance outwards across the white crescent; the other retinal elements had disappeared, leaving in their place an opaque fibro-granular detritus.

The optic nerve-entrance had an eliptical outline; its long axis was vertical; and the side bounding the staphyloma was abruptly excavated down to the level of the lamina cribosa. At the equator there were a few small white patches, where the absence of the choroidal epithelium, and the withering of its stroma, exposed the inner surface of the sclerotic to view; the retina had here undergone the same changes as at the posterior staphyloma. Elsewhere the retina and choroid were naturally adherent; the minute structure of the latter presented no obvious alteration, but the stratum of opticus fibres and ganglion cells was everywhere thin and opaque.

The ciliary processes were scattered, elongated, and interrupted. The lens was a flattened, chalky disc; its anterior capsule dotted with colloid globes, and coated externally with a tough, adventitious, fibrous membrane, was puckered, forming a central button at the anterior pole, which projected into the partially closed pupil. The hyaloid septum forming the posterior wall of the canal of Petit had been stripped from the ciliary body as far backwards as the ora serrata, and the lens unsupported behind swung to and fro. The iris generally was thin, its muscular tissue was atrophied, but the uvea was loaded with its usual pigment. Where it was tied to the cornea, the iris had a thickness of $\frac{3}{4}$ lines; the connection was very firm; it required some force to tear it through, and shreds of iris remained on the cornea. The great thickness of the iris at this spot was caused by a dense adventitious web of large multipolar cells which converged towards the cornea. The body of these cells contained a nucleus imbedded in pigment, with which the fibres also were loaded. The posterior elastic lamina seemed to pass unbroken across the synechia, up to which point the epithelium was also perfect; it was covered by a film of coagulated albumen. Corresponding to the synechia the corneal tissue was the seat of an active cell-growth.

VII.

GLAUCOMA.

(PLATE IV, FIG. 2.)

Excavation of the optic nerve-entrance and pulsation of the central vessels, are characteristic signs of glaucoma. The abruptness of the excavation and its frequent extension in a lateral direction, undermining the sclero-choroidal foramen, so different in their features from the gently sloping hollow of the simply wasted nerve-entrance, are unmistakable effects of over pressure. No traction from behind, in the direction of the nerve trunk, as has been supposed to occur, is competent to explain these appearances; they are the combined effect of excessive intra-ocular pressure, and wasting of the nerve tissue induced by it.

The spontaneous visible pulsation in the central vessels is another consequence of over-tension, a less degree of which suffices to produce the venous than the arterial pulse.

Capillary apoplexies in the retina occur in a large proportion of cases more particularly in the acute; and occasionally delicate filmy clots of blood are formed in the vitreous humour, which are sometimes connected by a slender thread with the point in the retina, whence the blood was poured out. The greenish colour of the vitreous humour and lens, which is orange in transmitted light, and is acquired from the hæmatine of the capillary hemorrhages, is not visible with the ophthalmoscope.

Glaucoma occurs in an acute and a chronic form which are connected by a numerous series of cases occupying an intermediate position. In 75 per cent. or more of all the cases, the active period of the disease is preceded by a premonitory—the "*prodroma.*" The transition from this to the active period is sudden and marked in acute, whilst it occurs by insensible gradations in chronic glaucoma. As it is a disease almost peculiar to mid-life and old age, its subjects are for the most part

presbyopic; but a rapidly increasing presbyopia is always suspicious, and often foreshadows glaucoma. The appearance of a halo round the flame of a candle, and occasional spontaneous flashes are common symptoms at this period. Now, too, an occasional dimness of vision is noticed, often towards close of day, or under the influence of emotion, and this is attended with vague pains in the eye and about the brow and temple. The pupil is rather large and sluggish, the iris and lens are pushed slightly forwards, and the size of the anterior chamber is still further diminished by a slight flattening of the cornea. A slight hardness of the globe may now be generally detected by careful palpation. The duration and intensity of these premonitory symptoms vary greatly.

In acute glaucoma the prodroma is followed by a sudden attack of violent pain in the eyeball, with rapid extinction of sight, often attended with sickness. The pupil is largely dilated and motionless, and sometimes has the peculiar greenish tint, to which so much importance was formerly attached. The ciliary region and the conjunctiva are congested, and the latter œdematous. The globe is very hard, the cornea is dull, and its sensibility is diminished.

In chronic glaucoma, the obscurations and pain, at first evanescent and separated by long and complete intermissions, become more frequent and last longer, until at length they are never entirely absent; the globe becomes harder. A remarkable contraction of the field of vision occurs,* the humours become cloudy, the pupil is dilated, and sometimes tied to the capsule of the lens, the iris is dull, and enlarged veinlets are often visible upon it. The convexity of the cornea diminishes, its surface is dull, sometimes vesicated, and its sensitiveness reduced to a minimum; by this time vision is reduced to a slight quantitative perception of light, or is wholly extinct.

* This mutilation of the visual field also occurs in acute cases, but under circumstances less favourable for its observation.

VIII.

INTRA-OCULAR CANCER.

The importance of an accurate diagnosis of cancer in its earliest stage, whilst yet restricted to the interior of the globe, cannot be over-estimated, because at this time only does extirpation of the organ offer a long immunity from a return of the growth.

The bright metallic reflection from the bottom of the eyeball, visible through the dilated motionless pupil to the observer's unaided eye, which has been considered so reliable a sign, is indeed not trustworthy, because a deceptively similar appearance is given by decolorized fibrinous clots, and deposits of lymph and tubercle in the vitreous humour, and by a detached retina.

The differential diagnosis of intra-ocular cancer with the ophthalmoscope rests mainly on the presence of vessels, and on differences in their distribution and arrangement from those of the retinal vessels. Where this test can be recognized the diagnosis may be considered certain, because the other objects which may be mistaken for cancer are non-vascular, at least with the exception of organized infiltrations of lymph in the vitreous humour, and the vessels of these are few and small as compared with those of cancer.

When the growth begins in the optic nerve-entrance or in the retina, and projects as a tumour into the vitreous humour, so long as this is transparent its vessels are visible with the ophthalmoscope, and may be distinguished by their larger size, and different arrangement from the more slender and arborescent vessels of the retina. But in most cases carcinoma, whether medullary or melanotic, commences in the choroid frequently splitting it into an outer, and an inner layer which together with the retina lies before the morbid growth, and frequently, but not always, prevents an exact appreciation of its character.

CASE.

A robust, athletic gentleman, æt. 50, had for some months had pain and progressive obscuration of the left eye. The pupil was large and sluggish; the retina was scarcely sensitive; and there was a bright metallic reflection from the lower and outer quadrant of the fundus.

OPHTHALMOSCOPIC SIGNS.—A vascular tumour projecting into the vitreous humour from the lower and outer part of the fundus; its vessels lie behind, and are distinct from those of the retina.

On dissecting this eye immediately after its extirpation a melanotic growth was discovered in the lower and outer quadrant of the choroid, reaching from near the optic nerve to the ciliary region. It was confined to this coat, within which it had evidently begun. The inner surface of the tumour was covered by the transparent retina, which was simply carried forward upon it, and not implicated in the growth; everywhere else the retina and choroid were separated by a grumous fluid.

CASE.

E. P——, æt 32, had occasional pain and obscuration of vision in the right eye during ten years. The sight then progressively failed, and within twelve months the retina became totally insensible; the eye now became very painful.

OPHTHALMOSCOPIC SIGNS.—A vascular tumour projecting forward from the back of the fundus, and on the inner side nearly reaching the back of the lens. Two sets of vessels are distinguishable, a slender anterior set having the distribution of retinal vessels, and a posterior set of much larger size coming out at several points in the surface of the tumour, and evidently belonging to it.

On dissection after extirpation of the eyeball, a medullary cancer was found in the choroid, which it had split into two layers. The front of the tumour was covered by the transparent retina.

But the ophthalmoscopic diagnosis of carcinoma is sometimes rendered impossible by detachment of the retina, and by opacity of the transparent media, which always occur in the progress of this disease. The former may take place at any time. At a very early period the retina may be upheaved by serum passively, drained from the chorio-capillaris, in consequence of the venous circulation having become obstructed by the pressure of the new growth; whilst at a later period, when the globe is distended, the same result ensues from the acute inflammation with effusion of serum, and hemorrhage which supervenes. When this has happened the cancer is concealed, and masked by floating retina.

CASE.

A lady had progressive obscuration of vision in the right eye during three months, at the end of which the retina was totally insensible to light.

OPHTHALMOSCOPIC SIGNS.—A dark projection in the region of the yellow spot. The lower and outer quadrant of retina detached. The nature of the case at this time was uncertain, but about a month afterwards, in consequence of acute inflammation and enlargement of the globe, extirpation was performed. A rounded, nodulated, melanotic tumour of the choroid projected from the back of the globe into the vitreous space, thrusting aside the retina which was completely wasted and funnel-like, from the axis of the eye. The interval between the retina and choroid was filled with brownish serum.

The tension of the globe is sometimes of use in determining the nature of doubtful cases, being for the most part diminished in sub-retinal dropsy, and increased in intra-ocular cancer; I believe attention was first called to this by v. Græfe.

IX.

TUBERCLE.

Tuberculosis of the internal tunics of the eye, or vitreous humour, has been mentioned as a condition likely to be mistaken for carcinoma. I am not aware of any recorded cases in which either has been observed in its very commencement; generally, the disease has made considerable advance before it comes under the notice of the surgeon. There is a bright, often primrose, tumour in the fundus which differs from carcinoma in being without vessels; but in tubercle, perhaps earlier than in cancer, the media become cloudy, and then the progress of the case alone decides its true nature.

X.

ENTOZOA.

The occasional presence of the Cysticercus tenuicollis in the anterior chamber of the human eye, and beneath the conjunctiva, had been long noticed, but since the invention of the ophthalmoscope its presence in the fundus of the eye has been frequently recorded by German surgeons; I am, however, acquainted with only a single case which has occurred in England. In most of the published cases the patients had long had tape-worm, and the greater frequency of cysticerci in the eye appears to depend on the greater prevalence of tape-worm in Germany.

The hydatid has been met with in two situations, beneath the retina and in the vitreous humour.

Whilst beneath the retina the hydatid forms a small translucent projection. In some instances, the head, neck, and body of the entozoon could be distinguished through the transparent retina; but where this was not possible the movements of the entozoon betrayed its nature.

The choroid upon which the cysticercus lies assumes for some distance around a greyish-yellow colour, and the neighbouring retina becomes raised by serum; together with these appearances, a granular and filmy opacity of the vitreous humour is observed. V. Græfe records a case in which he first observed the entozoon behind the retina, and subsequently in the vitreous humour, at some distance from its original situation where a laceration of the retina was apparent. The track of the entozoon from its former to its new situation could be recognized by an opacity of the vitreous humour. It is probable that what was seen in this case occurs in all, that the hydatid is always originally behind the retina, or within it, or in the choroid, and that when it has attained a certain size it bursts these tunics and escapes into the vitreous humour. Here it has been observed under two conditions, free and able to change its

locality; and confined within a membraneous sheath, which is probably formed in the same way as the fibroid capsules that form around inanimate foreign bodies, and has the same conservative object.

The presence of the hydatid causes a corresponding interruption of the field of vision, so that in some cases the figure of the shadow has shown the nature of the case. In whatever locality it be present the entozoon provokes an insiduous and intractable inflammation which terminates in the destruction of the organ.

(Several most interesting cases have been published in the Archiv. für Ophthalmologie.)

HARRISON AND SONS, PRINTERS, ST. MARTIN'S LANE, W.C.

EXPLANATION OF THE PLATES.

PLATE I.

FIG. 1.—The healthy fundus, showing the optic nerve-entrance and the distribution of the retinal artery and vein.

FIG. 2.—Inflammation of the retina. The colour of the optic nerve-entrance approaches that of the surrounding fundus, and its outline is masked; the retina is hazy, the vessels are swollen, and where they dip away from the surface partially lost to view. (This and the preceding are reduced copies of P. i and xi, Beitrage zur Path. des Auges Dr. Ed. Jaeger.)

PLATE II.

FIG. 1.—Capillary apoplexy of the retina.

FIG. 2.—A much enlarged view of the region around the optic nerve, with detachment of the lower hemisphere of the retina.

PLATE III.

FIG. 1.—Inflammation of the choroid with exudation of lymph and disturbance of the pigment-epithelium.

FIG. 2.—Atrophy of the choroid, the epithelium has disappeared from large segments of this coat, leaving the yellowish inner surface of the sclerotic visible. The black markings are flocs of pigment. The flat ochreous yellow vessels are the choroidal veins. (Jaeger. P. viii.)

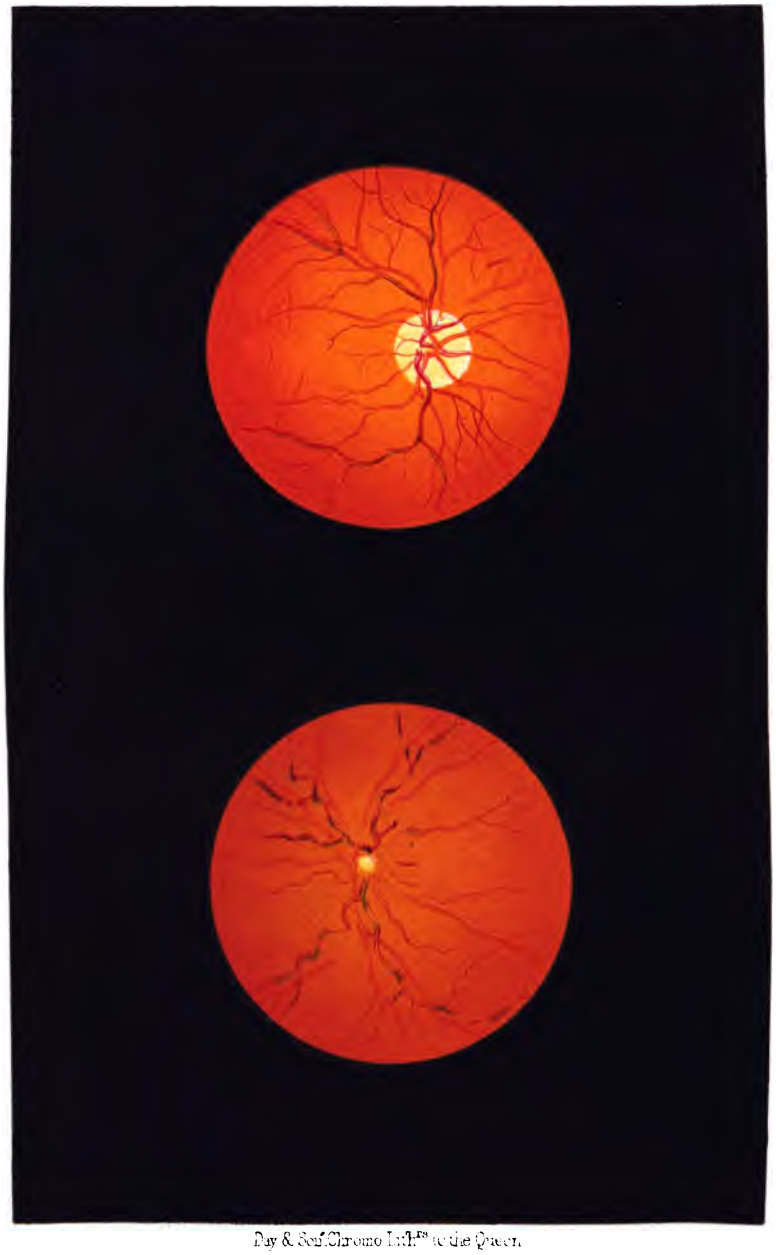
PLATE IV.

FIG. 1.—Sclero-choroiditis posterior, posterior staphyloma. The staphyloma corresponds to the white arc that embraces the outer side of the optic disc. The vessels seem to perforate the disc eccentrically, at the side opposite to the staphyloma.

FIG. 2.—Glaucoma. A deeply excavated optic disc. The veins are abruptly bent, and displaced laterally at its margin.

FIG. 3.—Diagram of posterior synechiæ. Adhesions of the pupil to the capsule of the lens.

PLATE I



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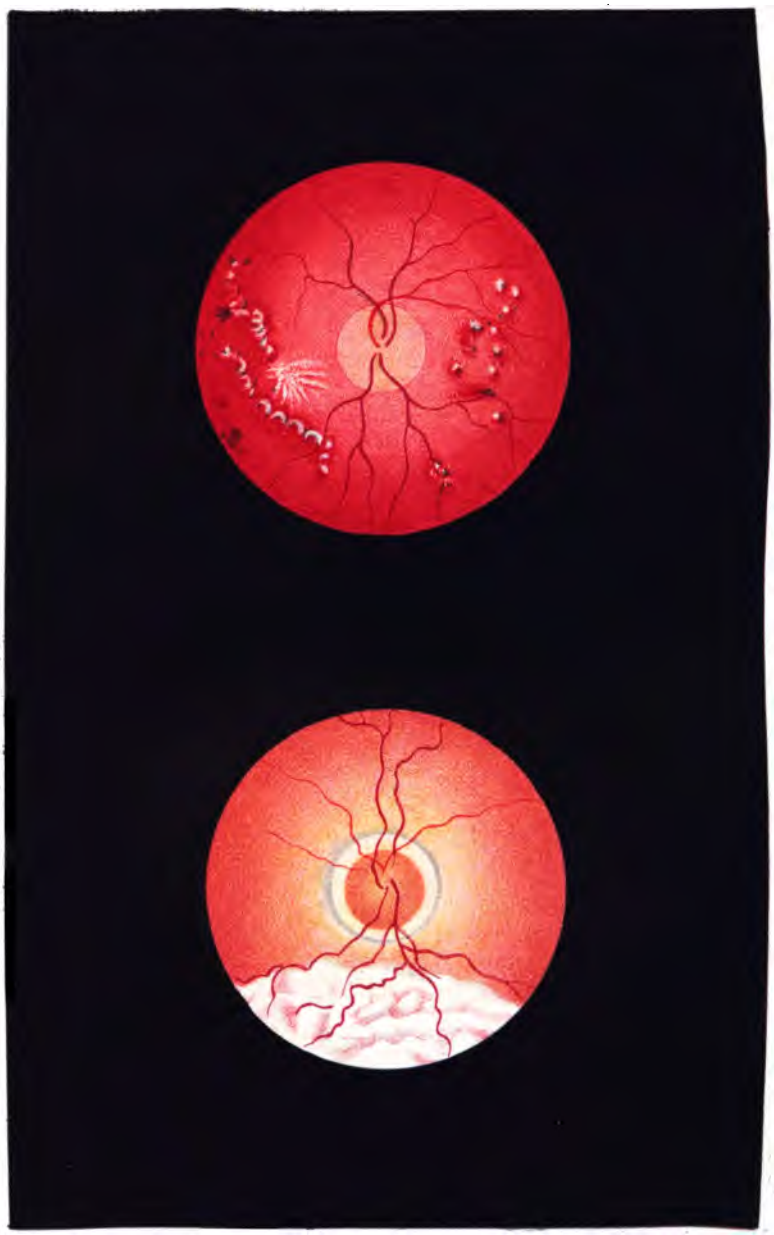
Day & Son Chromo Lith.rs to the Queen.



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Day & Son Chromo Lith.rs to the Queen

PLATE II.

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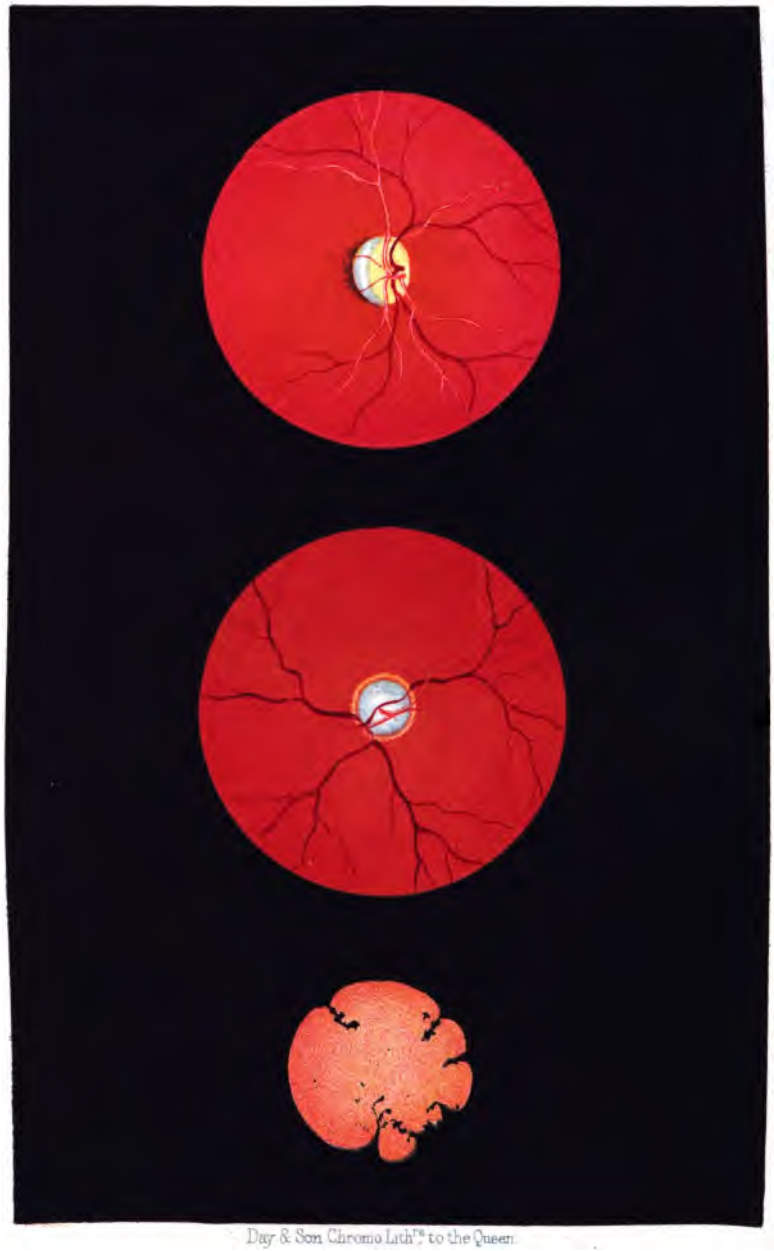
Day & Son Chromo-Lith^rs to the Queen



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Day & Son Chromo Lith.rs to the Queen.


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